Radio, Electronics and Communications

FORMERLY "RADIO & ELECTRICAL REVIEW" — WIDELY KNOWN SINCE 1946 AS "R. & E."

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In This Issue. . .

- R.F. Signal Source Impedance
- Electronics in the Automotive Industry
- Crystal Oscillator Module for Electronic Control Systems
- Hi-Fi for Mini-Money—II
- Listening Post, New Products

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 22 NUMBER 7

SEPTEMBER 1, 1967 PRICE 25c

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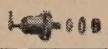
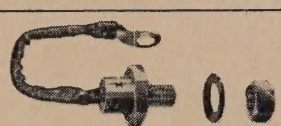
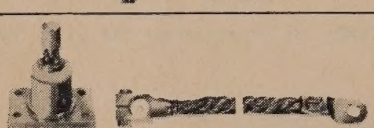
	Current	Transient Peak voltage	Peak inverse voltage	Type number	Type number (reverse polarity)	Type number heatsink
	Germanium: 3.8 A	120V	95V	OA 31		
	Silicon: 0.01 A	2500 V	2000 V	BY x 11		
		2500 V	2000 V	BY x 12		
	Silicon: 0.2 A	1600 V	800 V	BY x 10		
	Silicon: 0.75 A	1250 V	800 V	BY 127		
	Silicon: 1 A	1250 V	800 V	BY 100		
		650 V	450 V	BY 114		
	Silicon: 6 A	1200 V	800 V	BYZ 10	BYZ 16	56235
		900 V	600 V	BYZ 11	BYZ 17	
		600 V	400 V	BYZ 12	BYZ 18	
		300 V	200 V	BYZ 13	BYZ 19	
	Silicon: 10 A	800 V	400 V	BYY 24	BYY 25	56238
		600 V	300 V	BYY 67	BYY 68	
		400 V	200 V	BYY 22	BYY 23	
	Silicon: 20 A	1600 V	800 V	BYX 13/1600	BYX 13/1600 R	56236
		1200 V	600 V	BYX 13/1200	BYX 13/1200 R	
		1000 V	500 V	BYX 13/1000	BYX 13/1000 R	
		800 V	400 V	BYX 13/ 800	BYX 13/ 800 R	
		600 V	300 V	BYX 13/ 600	BYX 13/ 600 R	
		400 V	200 V	BYX 13/ 400	BYX 13/ 400 R	
	Silicon: 25 A	200 V	75 V	BYX20/200	BYX20/200R	56228 with adaptor 56232
	Silicon: 40 A	1600 V	800 V	BYX 15	BYX 16	56237
		1200 V	600 V	BYY 77	BYY 78	
		1000 V	500 V	BYY 75	BYY 76	
		800 V	400 V	BYY 15	BYY 16	
		600 V	300 V	BYY 73	BYY 74	
		400 V	200 V	BYZ 14	BYZ 15	
	Silicon: 150 A	1200 V	600 V	BYX 14/1200	BYX 14/1200 R	56259
		1000 V	500 V	BYX 14/1000	BYX 14/1000 R	
		800 V	400 V	BYX 14/ 800	BYX 14/ 800 R	
		600 V	300 V	BYX 14/ 600	BYX 14/ 600 R	
		400 V	200 V	BYX 14/ 400	BYX 14/ 400 R	

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ENQUIRY 573. USE FORM AT REAR.

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(Established 1946)

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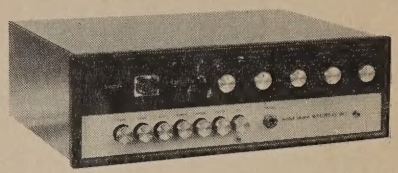


THE NEW AWA HIGH FIDELITY STEREO AMPLIFIER— & WITH EXPORT POTENTIAL

Following the success of the A.W.A. High Fidelity Stereo Amplifier ST40A introduced to the New Zealand and Australian markets last year, A.W.A. N.Z. engineers have now developed the higher powered Stereo 90, illustrated on the front cover.

The Stereo 90 specification and quality is unsurpassed by imported equipment and features some new and original design approaches.

The ST90 is in quantity production and initial New Zealand distribution has been completed. Export possibilities appear excellent, particularly in Australia, and are being fully explored.

ENQUIRY 640. USE FORM AT REAR.

Coming . . .

- An Ultrasonic Power Meter
- Protection Circuit for Transistorised voltage regulators.
- Thermal Resistance and maximum powers of semi-conductors
- Looking at Second Break-down in Transistors.
- A high impedance D.C. Amplifier for Laboratory use.
- A 70cm transmitter using a varactor tripler.

Also . . .

Circuit & Service Data.

New Products.

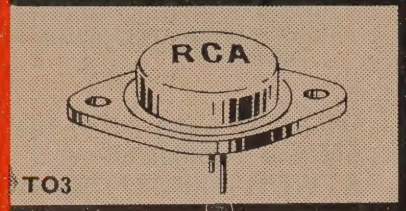
Listening Post.

Book Reviews.

News from Wellington.

NELCON II Conference news.

AWA FOR SILICON TRANSISTORS



TO3

TO66

TO5 HEAT SINK

TO5

TO104

RADIO FREQUENCY TYPES

RCA Type	Structure	Case	FT	PT	VcBO	
40235	SI NPN	TO104	1,000 MHz	180 mW	45	50 mA
40236	SI NPN	TO104	1,000 MHz	180 mW	45	50 mA
40240	SI NPN	TO104	800 MHz	180 mW	45	50 mA
40242	SI NPN	TO104		180 mW	35	50 mA
40245	SI NPN	TO104		180 mW	35	50 mA
2N3478	SI NPN	TO104	900 MHz	200 mW	30	
2N3553	SI NPN	TO5	500 MHz	7 W	65	1 A (peak)
2N3866	SI NPN	TO5	800 MHz	5 W	55	400 mA
40444	SI NPN	TO3	100 MHz	140 W	120	20 A

GENERAL PURPOSE TYPES

2N2102	SI NPN	TO5	120 MHz	5 W	120	1 A
2N3053	SI NPN	TO5	100 MHz	5 W	60	700 mA
2N4036	SI PNP	TO5	60 MHz	7 W	90	1 A
2N4037	SI PNP	TO5	60 MHz	7 W	60	1 A
40231	SI NPN	TO104 (near)	60 MHz	1 W	18	100 mA
40233	SI NPN	TO104 (near)	60 MHz	1 W	18	100 mA
40310	SI NPN	TO66	750 KHz	30 W	35	4 A
40313	SI NPN	TO66		35 W	300	2 A
40314	SI NPN	TO5	100 MHz	5 W	40	700 mA
40317	SI NPN	TO5	100 MHz	5 W	40	700 mA
40319	SI PNP	TO5	100 MHz	5 W	40	700 mA
40327	SI NPN	TO5		5 W	300	1 A
40389	SI NPN	TO5 + Heat Sink	60 MHz	7 W	60	700 mA

POWER TYPES

2N3054	SI NPN	TO66	800 KHz	30 W	90	4 A
2N3055	SI NPN	TO3	800 KHz	115 W	100	15 A
2N3442	SI NPN	TO3		117 W	150	10 A
2N3772	SI NPN	TO3		150 W	100	10 A
2N3773	SI NPN	TO3		150 W	160	16 A
40250	SI NPN	TO66	1 MHz	29 W	50	4 A
40251	SI NPN	TO3	500 KHz	117 W	50	15 A
40363	SI NPN	TO3	700 KHz	115 W	70	15 A
40364	SI NPN	TO66	15 MHz	35 W	60	7 A
40411	SI NPN	TO3	800 KHz	150 W	90	30 A

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VR33

ENQUIRY 636. USE FORM AT REAR.

Letters to the Editor...

Sir,

Recently you published information on availability of pre-recorded tapes for checking distortion in playback amplilers, but I am unable to trace this—can you help?

D. G. BROWN.

We are not sure of a ready source for obtaining these tapes. However, we suggested the N.Z. Tape Recording Club, which has a tape library, may be able to help. Their address is P.O. Box 5368, Wellesley Street, Auckland.

If they are unable to assist we feel sure Mr. Judd with whom we have previously had correspondence may be able to assist. His address is F. C. Judd, Amateur Tape Recording, Haymarket Press, 86-88 Edgeware Road, London, W.2, England. Ed.

Sir,

Some time ago there was a series of constructional articles in your magazine for utilizing the VCR 97 cathode ray tube in a six inch television set; I should be very grateful if you would let me know which copies these articles were in and if they are procurable now and also the price of same.

Enclosed please find a stamped addressed envelope for reply.

Thanking you in anticipation.

L. J. RYAN,
Dannevirke.

Further to your enquiry we are pleased to advise that the issues concerned were:

November, 1964.
January, 1965.
February, 1965.
March, 1965.

These issues are available at 2/6. each. We await your advice concerning the despatch of these copies.

Thanking you for your enquiry.

Ed.

Sir,

Enclosed is a year's subscription for the magazine Radio, Electronics and Communications.

In addition I am interested in purchasing all the back copies of this publication which include circuit diagrams and basic servicing instructions of currently produced commercial radio and TV appliances. I have included a further $4 to cover this cost.

Will you please debit or credit my yearly subscription with the balance and advise me.

D. G. PARKER,
Papakura.

We thank you for your interest in our feature and have done as you requested. Ed.

Sir,

Could you let me know which issues of your magazine contained a series of articles on Domestic Stereo Systems.

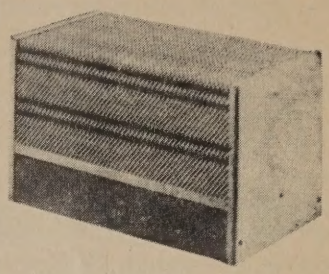
Also if available, and the complete cost including postage.

C. J. MACKEY,
Queenstown.

The series on Domestic Stereo appeared in May 1962, June 1962, July 1962, September 1962, November 1962. The cost of these would be 1/3 post free. Ed.

70-WATT AUDIO POWER AMPLIFIER

BUILT ON A "FRYCO"



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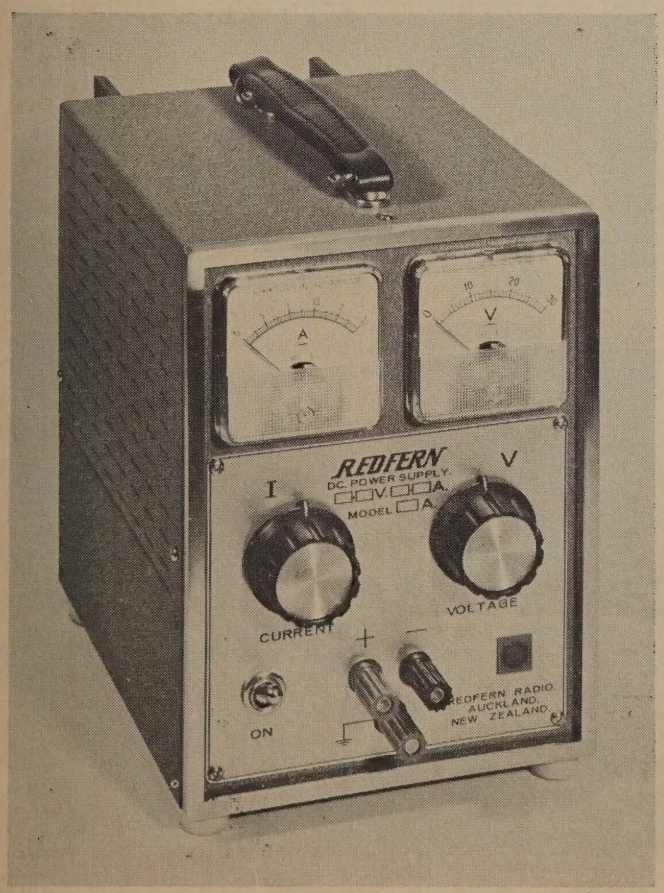

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Features quality construction and appearance, silicon circuitry, low noise and ripple, moderate price, 12 months warranty, stock delivery.

Specification. Output continuously variable .6 to 30V. at 2 Amps. load regulation .64%, line regulation 210/250V. .64%, ripple and noise 40 micro-volts RMS or less, temp range 0° - 55°C. Protection continuously variable auto-resetting current limiting from 18 MA to 2.9A. sharp current voltage cross over, standard ¾" spacing binding posts also rear mounted output terminals, remote sensing, floating output up to 250V. DC, fibre glass circuit board, voltage control by combination potentiometer and cam operated transformer tap changers.

Length 10⅛" width 6⅛" height 8½" weight 16 lbs.

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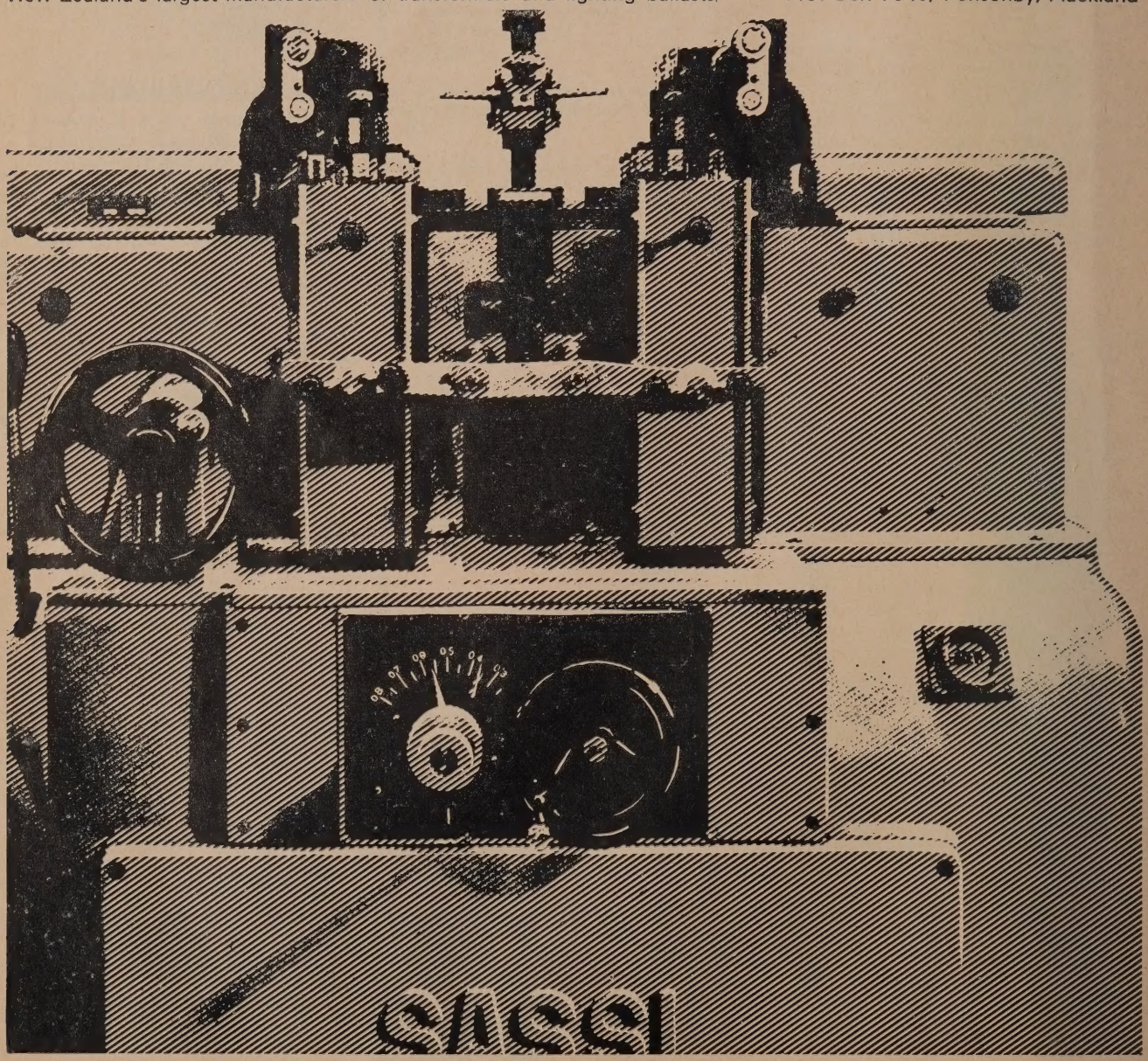


ENQUIRY 637. USE FORM AT REAR.

Electronics at the Bed-side.

The recent visit to this country of Dr. Cameron Baird, from Melbourne, and his lectures at Auckland Hospital on automation and instrumentation in hospitals are a reminder, if one is needed at all, of the steady march of electronics into everyday life. Even a visit to a hospital must now be regarded as almost certain in one's lifetime since American authorities estimate that one person in two will, before they are sixty five, spend at least three days in a hospital bed. With the trend to centralised social and medical services in this country almost everyone will, at some time, visit a hospital even if only for an x-ray or blood test.

The increasing use of hospital facilities puts a strain on money, personnel, equipment and space. The situation is worsened when some people, particularly at middle age, are in and out of hospital a good many times in a few years. Dr Baird highlighted the purely routine problem any patient presents as a "file" mentioning the possible need for x-rays blood and urine tests, cardiography, sugar level and similar tests. Most hospitals at present carry out these tests at the request of the medical staff after consecutive examination of the patient, perhaps over several days slowly building up a case history and a massive collection of paper!

Any examining doctor, and there will probably be two or three specialists involved in anything apart from a minor case, has to wade through a thickening file of notes to find the report of interest to him and then order yet another test. If the patient is a "previous" there are chances all this has been done before but the results of previous examinations may not be readily accessible or may be at some distant hospital.

Part of the answers to these problems is already available by the use of computers to store (and provide) clerical information and previous history of the patient. The logical extension of this is the rapid presentation of selected information on closed circuit T.V. screens strategically located about a hospital. By this means a doctor would "call up" an x-ray on a patient by pressing or dialling the required code—any other information on the patient would not be presented and thus files would not be physically carried about wards. Suitable secrecy systems are already available so that unauthorised people could not quiz the computer.

Information into such a computer system would be obtained by suitably automating many of the routine tests such as blood pressure and blood analysis onto punched cards for feeding into a central service.

The next logical extension of this is to provide "on line" monitoring of the patient whilst actually in the hospital bed. Many intensive care needs such as temperature, blood pressure, pulse and respiration could be continuously monitored by electronic equipment at the bedside and the information fed into the central system for multi-point availability. Such a system would relieve nursing staff of continuous watches on seriously ill patients. Any change in the patient's condition could set off alarms in the monitoring equipment to alert the medical and nursing staff. Servo controlled electronic units are already in use in some research hospitals to control continuously and monitor intravenous injections (diabetes for instance) so that the inflow/outflow pattern is as required and any change in the patient's condition produces the required change in the injection solution or flow.

A more sophisticated use of electronics in hospitals could result from the "screening" technique proposed by some overseas medical technologists. Here patients would receive a full series of tests, x-rays and so on immediately upon admission. By this means a fairly full report could be prepared within hours of first admission instead of a number of spread-out tests over several days as at present. For instance; a man admitted for a kidney operation would have all the possible tests concerning kidney condition done within hours of arrival. In fact, he would probably be first admitted to the Test Ward. Ideally, this would contain batteries of medical electronic equipment designed for bed-side use and for the outputs to be fed into a central computing system. Minutes later the required information could be available on a character reading screen in the specialist's office. Some fanciful writers have suggested the computer could make a diagnosis.

We would not go this far but there is no doubt that electronic automation will come to medical laboratories in New Zealand over the next few years and that central computing and information retrieval systems may be in use perhaps by 1975. The bed-side analyser scheme could well be seen here before then. New Zealand has a world wide reputation in specialised surgery and social medicine; coupled with this there are several medical electronic units of world standard. Electronics in hospital management (for that's what it is) is a new field and New Zealand could be a leader —if it wanted to. —C.W.S.

Electronics in the MOTOR INDUSTRY

A lecture to acquaint the Automotive Industry of changes and impending changes to motor transport through the wider applications of electronics.

by K. J. Gough, M.Sc., Grad. N.Z.E.I.*

Presented by the New Zealand Electronics Institute Incorporated, Shell Theatrette, 20 Sept, 1967.

Facilities provided by Shell Oil New Zealand Ltd., who with the Society of Automotive Engineers, have contributed materially to the cost of presenting the lecture.

Introduction

The phenomenal growth of electronic technology and its associated industry has and will continue to revolutionise all aspects of our life. Technical feats previously undreamed of, are now performed electronically every day, devices previously impractical for reasons of size, complexity or cost, and new versions of old devices have all been constructed using modern electronic techniques and have become commonplace.

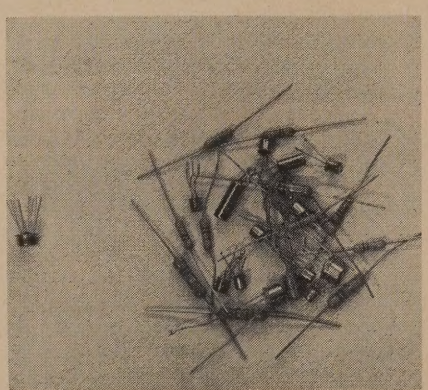
The development of transistors and other solid-state devices such as silicon diodes, silicon controlled rectifiers and so on has been to a great extent responsible for this growth, or at least forms one of the more spectacular facets of it. Solid-state electronic devices are rugged and small, thus allowing complex apparatus to be packed into small spaces, and furthermore these devices are extremely reliable if properly used. Transistors and some of the other solid-state devices can be operated as relays and switches, and have higher operating speed and eliminate the periodic maintenance necessary for the mechanical contacts they replace. Present electronic research points the way to even more spectacular developments in the field of miniaturisation; the replacement of "discrete" circuits composed of the familiar resistors, capacitors and transistors by tiny "integrated" circuits will continue to make existing devices cheaper and smaller, and hence to make more complicated electronic functions practicable.

This revolution has not been entirely without its problems however, and one of the most troublesome of these is the continually expanding demand for people trained in the use of these new techniques. Although the real solution to this problem requires the training of specialist technicians, and this lies with the educational authorities, it is important that experts in other fields should at least be aware of the potential and the possible applications of the new technologies.

Electronics is already affecting the motor industry in many quite separate ways, and the influence of electronics in the industry can be expected to increase in all these spheres. Let us however deal separately with those applications of electronics which are already planned; and with those possible future applications which are only at the experimental stage at present.

The Present Influence of Electronics

Three areas of influence can be seen at present: first, the administration of the motor companies, just as for that of all large ventures, is increasingly dependent on the electronic computer for data handling, market survey, and after sales history analysis. The most interesting of these uses to the consumer is the promise of detection of design faults at an early stage in production, through scientific analysis of the data accumulated from early maintenance experience.



Some of the devices which will be seen more in cars.

Next, the actual design and production of the motorcar is being changed by electronics in several ways. Design studies are already computer aided in some companies, particularly (following the now universal practice in the aircraft industry) for stress analysis in monocoque sections. The use of electronically controlled, programmed machine tools can be expected to find application in the motor industry, just as it is doing in other industries. In this connection it may be remembered that the Physics and Engineering Laboratory of the D.S.I.R. has developed and demonstrated numerical control machine tools, and we in New Zealand can be considered to be up to world standard in research in this field, even if we are a little slow in getting these techniques into production. An interesting possibility brought about by the use of programmed tools is the stockpiling of data-tapes instead of spare parts, and the instant incorporation of new or modified designs which can be transmitted from place to place by Telex or radio. This would avoid the costly resetting of production tools, and the lengthy wait for arrival of shipped parts.

A whole range of possibilities in production is opened up by the invention of the laser, with its capability for making ultra high precision measurements, plus of course the more spectacular properties of laser beams that the writers of popular fiction use for various macabre purposes. It is reported that motor factories in Eastern Europe are already using lasers to "drill" tiny holes in refractory materials for fuel injection nozzles.

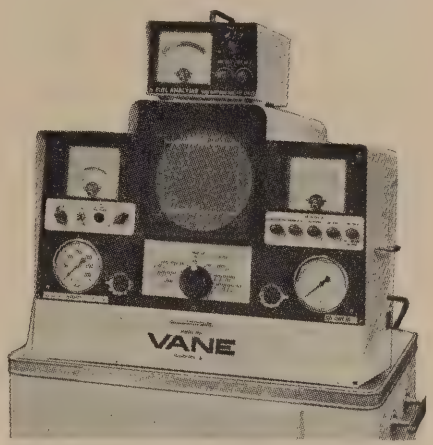
Electronic test instruments have already made their appearance, and such equipment as ignition analysers are now standard equipment at many garages. Overseas trends indicate that we can expect to see new and more comprehensive

*D.S.I.R. Lower Hutt, Wellington.

electronic test instruments in the future, especially in specialist "diagnostic centres." This development has however highlighted one of the problems of all progress—that people must continually be retrained in the new techniques as they become available, if any advantage is to be gained by the new methods. This is not to say that all future motor engineers will need to study electronics to New Zealand Certificate in Science level. Just as it is a matter of experience to deduce carburettor maladjustment from the colour of the deposit in the exhaust, so it is a matter of experience to look at an oscilloscope display and deduce that the plug gap is too wide; one need not know anything about the chemistry of aerosols or the electron-optics of the cathode ray tube. The point is that these "new fangled gadgets" can give precise and accurate information, but the operator of the test instrument must be trained to correctly interpret the indications that the machine gives.

Finally, and of all the applications of electronics to the motor industry, the one which most people are interested in, is the use of electronic devices in the product—the motorcar itself. The most widespread present use of electronics in the motor vehicle, and one that is often overlooked is the car radio. Car radios have been with us for some time of course, and have already undergone a quite remarkable decrease in size as a result of transistorisation. The trend toward miniaturisation is continuing and the first auto radios using integrated circuits will appear in (American) 1968 models. Integrated circuits also look likely to bring the cost of self-tuning, signal seeking radios down to a reasonable level, this will enable the radio to be moved from the dashboard, which if the safety experts have any say, will be out of reach anyway. Cartridge loading tape players are now popular extras available on most American 1967 models, and the application of integrated circuits will almost certainly lower both the price and size of these.

The first use of modern electronic devices in the running gear of cars was the use of silicon diode rectifiers on alternators. This first application represented a real risk for the manufacturers, because the use of this device in such a strategic position effects both the reliability and overall cost. The success of this experiment is by now well known and has encouraged motor companies to entrust more of their important tasks to electronic devices. It is incredible to anyone who has studied the indisputably superior



An example of one of the oscilloscope engine testers on the market.

record of alternator systems that manufacturers persist in putting DC generators on new models. British manufacturers have had alternators as options on luxury models for some time, and such equipment is now standard on Jaguar's E-type and 420 series, and on the most expensive Fords. Rootes however is the first British firm to make alternators standard on a "family saloon" model.

Closely allied with the diode rectifier/alternator combination is the use of all solid-state, contactless voltage regulators; the first of these will be fitted as standard equipment by Ford of America and some other companies on 1968 models. The use of electronics in this application will lead to greater reliability, longer life and higher efficiency since all mechanical contacts and electromagnetic relays will be eliminated.

The complete elimination of relays for such things as the control of small servo motors will be another immediate application; some luxury models contain almost thirty DC motors for such things as window winding, seat moving and so on. The use of transistors to control these will eliminate a troublesome source of unreliability. Even for the more modest car transistor control provides attractive possibilities for the speed control of the electric windscreen wiper, and in fact a locally produced accessory to do just this is already on the market.

Electronic tachometers are familiar to enthusiasts as accessories, and some high performance cars now have these fitted as standard, an example is the 420 series Jaguar which has an electronic tach. supersede the traditional mechanical one, which was driven direct off the camshaft of the XK engine. A large number of other electronic instruments are being considered, such as high accuracy fuel gauges, and several manufacturers such as Ford of America have experimental speedometer/odometers which are electronically operated.

As well as providing new and better accessories however, electronics is playing it's part in the development of the engine itself. The use of transistorised electronic ignition for racing cars is now standard, the improved high speed performance being decisive, but even for the ordinary motorist the improved reliability gained by eliminating the breaker point erosion constitutes a real gain. New developments in electronic ignition circuits include the use of mass produced integrated circuits, which should bring the price down from its present "luxury optional extra" level, and the complete elimination of the breaker points by means of either a photo-electric or magnetic pickup to detect the position of the camshaft. This last development not only eliminates another moving part, but also does away with the possibility of ignition "jitter" caused by backlash or torsional vibrations in the distributor drive. Another development in ignition design is the investigation of "fast rise" units, these produce such a rapidly rising voltage across the plug gap, that they are capable of firing even a fouled plug. At present however these systems are rather expensive since they require a separate coil for each plug, but several companies are keeping a very close eye on advances in this field.

One of the most interesting electronic devices to be demonstrated for auto use was shown at the London Motor Show in October 1966, it was an electronic fuel injection system demonstrated by the Brico subsidiary of the Associated Engineering Group. The system consists of a pump which maintains the fuel pressure at 25 p.s.i.g. in a fuel manifold; this manifold is connected through solenoid operated valves to the injectors, which are in the intake manifold downstream of the throttle valves. The solenoid valves are operated by a pulse generator, and the length of the pulses is controlled by signals from transducers (measuring devices) measuring inlet manifold pressure and temperature. Although these inputs are sufficient to control the mixture during normal running, an extra transducer is fitted, which measures cooling water temperature, and causes extra enrichment for cold starting. Preliminary experiments indicated a saving of twenty per cent in petrol consumption at thirty miles per hour for a Rover 2000TC, and for a 4.2 litre E-type Jaguar the claimed power is seven per cent up on the three SU carburettor figure.

The Future

We can expect electronics to play an increasingly important role in the motor industry, and the possible applications which can be imagined are numerous. The various devices which have already been suggested in the electronics literature range from the straightforward schemes that we will almost certainly see operating within the next few years, through to far-fetched, futuristic dreams which will require major technological advances before they become practicable. I shall therefore only mention those applications which seem to be possible at the present state of our electronic knowledge.

A multitude of different devices relating to car safety have been suggested, some of those at present being investigated include headlight and taillight dimmers. It may be remembered that General Motors were interested some years ago in an automatic device for dipping headlights in the face of oncoming traffic, and it now appears that such a device is truly practicable. A new variation on the same theme is a device which will reduce taillight intensity at night to avoid blinding following drivers with the wattage normally used during the daylight hours. Electronic devices are also being considered to automatically drop the angle of the rear vision mirror if a following driver fails to dip his headlights, and to automatically return the mirror if he either dips or goes away. Several manufacturers are said to be working on a central "trouble centre" which would detect a malfunction in any of the car's system and display an appropriate dashboard message such as "left back tire soft", "seat belts not fastened" or perhaps even "microwave speed detector ahead."

Another interesting device concerned with vehicle safety is a non-skid braking device being investigated by the Bendix Corporation. This device will measure ground velocity and compare this with the peripheral velocities of each wheel. If a wheel starts to lock up the braking effort on that wheel will be reduced until the

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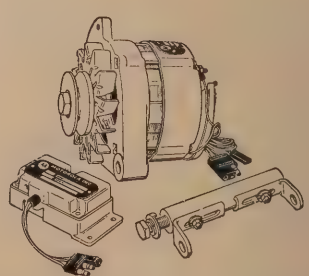

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wheel spins up to its correct speed, control then returning to the normal hydraulic system. The system would be essentially an electronic realisation of the mechanical Dunlop Maxaret system so successfully applied to the technically revolutionary Jensen FF. Many people are doubtful whether any car manufacturer will ever allow so much of the control of the car to be handled by an electronic device. "What happens if a transistor blows up," is a typical remarks, but it is known that the U.S. Airforce entrusts multimillion dollar aircraft to exactly the same sort of electronic device, with suitable failsafe features of course.

An efficiency and performance device which has been seriously suggested is an "ignition optimiser." This would comprise a sort of elementary computer fed with data on engine speed, manifold vacuum, rate of acceleration and perhaps even peak combustion chamber pressure. The output of the computer would alter the ignition advance to the optimum value for the measured conditions. This device of course represents the same approach to ignition timing that the electronic fuel injection is to carburation. It can be stated with certainty that such a scheme would be prohibitively expensive at present, but that mass production and the availability of integrated circuits could bring the price down to an acceptable level in the future.

The reduction in cost of quite complex systems achieved by the use of integrated circuits also makes practicable an old dream: the electronically controlled transmission. The idea is to get rid of the bulky and power consuming hydraulic components of standard automatic transmissions, and to have a standard type gearbox electronically controlled. Such a transmission has been supplied by a GM subsidiary and successfully used on the Chaparral sports-racing car. This experimental transmission does not use integrated circuits since it is only a prototype, so it can hardly be considered suitable for installation in the family saloon if only for reasons of cost.

However, electronically controlled transmissions will certainly appear on mass produced cars in the near future.

The list of prototype devices could go on and on: devices to generate flashing or "rippling" tail-lights, through to short range infrared radar to prevent nose to tail collisions. The field has only just started to open up, and although some of the present experiments may never see quantity production one thing is certain: the cars that come off the production lines in five years time will have more transistors in them than they have teeth on their ring-gear.

There followed a discussion which is summarised below by our Wellington correspondent.

Question: Will Mr Gough tell us about the prospects of electric cars?

Gough: The electric car is at present retarded by the lack of a suitable battery, as it has only a radius of 100 miles at present. This has its uses, but further development of the battery is needed. The fuel cell is the most promising line of development (where fuel is converted to electrical energy), but the difficulty here is the high temperature. However, exsiting forms of electric traction—such as the electric locomotive and the diesel-electric engine—are tending to use solid-state control. The petrol engine, while theoretically inefficient, in practice is robust and highly practical.

An individual test instrument—an exhaust gas analyzer.

Question: I remember the electric gear box from the early 1920's. Does this mean a return to this?

Gough: The introduction of electronics makes these practical, and makes control more sensitive.

Chairman: The radio trade had to learn to use the transistor. This meant new concepts, new equipment, and in short, complete re-education. After the transistor came Tv, and the trade had to re-educate itself in the complexities of Tv and FM. This it did successfully. I would like to ask: What is the motor trade doing to prepare itself for the advent of solid-state in the motor-car?

Mr Thompson (Govt. Printing Office): The industry itself will have to provide the training, if it is to give the service.

A teacher: We are providing training.

An auto-electrician: There is training in transistor ignition and rectifiers, but we are limited by the material we have to work with.

Mr Harris (teacher): There has been training in transistor ignition and rectifiers provided, for the past five years.

Chairman: Should the lecture be repeated, at an evening session?

Mr Harris (Institute of Motor Industry): Yes, we would like an evening session. (The speaker favoured holding the meeting at the Hutt in a hall accommodating 100.) The Institute of Motor Industry has a large membership of young chaps, and the S.A.E. is similar.

Chairman: It has been suggested that a lecture should be given in another year or two years. What is the meeting's view?

(A concessus of opinion expressed the wish to hear another lecture.)

Chairman: I call on Mr F. D. Tonkin, President of the Institution of Engineers, to pass the vote of thanks to the speaker.

Mr Tonkin: Mr Gough has dug very deep in his researches for this lecture—we owe him a debt of gratitude. He presented his paper very well, and it was an excellent paper. I noticed that while he followed it very closely, he did not read from it, and elaborated well on details. Electronics was unknown to those of us who trained earlier, although I remember playing with receivers in the "20's" when we had to make everything except the valve. Fifteen years ago computors were unknown, and now they are significant parts of our lives and work. Mr Gough's presentation was very good, and I ask you to join me in expressing your appreciation by acclamation.

The meeting was then closed by the chairman.

Electronic control systems are relying increasingly on the use of highly stable frequencies. For the large variety of applications here involved, the author's firm has developed in company with the firm of Quarzkeramik a small compactly designed crystal oscillator module which generates any desired frequency in the range of 1 to 10MHz with an accuracy of 10^{-8} and may be expanded to provide coverage of the range of 10Hz to 100MHz by adding frequency dividers and multipliers.

Crystal Oscillator Module for Electronic Control Systems.

by H. Pichl*

The demands which have to be met by crystal oscillators used in communications and automatic control systems are essentially different from those satisfied by more expensive precision crystal oscillators (Fig. 1). The features called for are:

- Shortest possible warmup time so as to allow operation on a demand basis.
- Low power input as precondition for portable battery-operated equipment.
- Modest dimensions and shock-mounting.

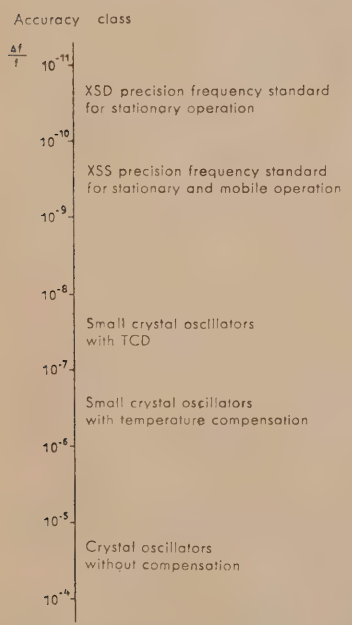

Fig. 1 Classification of crystal oscillators according to accuracy the classes denote the order of magnitude of the limits of error which are not exceeded during a 24-hour period although all disturbing influences are simultaneously present. Whereas the author's firm have hitherto confined their interest to high-precision oscillators, the new crystal oscillator modules extend the existing line of types to include the lower accuracy classes that are sufficient to meet the less exacting requirements of automatic control systems.

***H. Pichl, Rohde and Schwarz, Munich**

Suitable Crystals

Oscillators of great frequency stability are realized for the frequency range of 1 to 10MHz with AT quartz crystals in the holder HC27/U or HC6/U (1). If lower or higher frequencies are required, it is best to employ frequency division or multiplication. Quartz crystals of this type are subject to relatively little aging, viz. about 1×10^{-8} per week after three or four weeks of operation. Their short - time stability (2) corresponds to $(\Delta f/f)$ rms $<1\times10^{-9}$ over an integration time of 1 sec; that of quartz crystals with a soldered holder is even $<1\times10^{-10}$. If such crystals are adequately shielded from environmental influences that would degrade their stability, they may be used to realize oscillators of the 10^{-8} to 10^{-9} accuracy class.

Stabilization of Frequency

The primary influence that degrades frequency stability is temperature cycling. In order to overcome dependence on temperature it is necessary right at the outset to develop quartz crystals with relatively low temperature coefficients (3). Certain quartz cuts exhibit very low temperature coefficients within certain temperature ranges. As may be seen from Fig. 2, the temperature coefficient of quartz changes its sign as a function of temperature. The temperature dependence of the frequency in the region of the turning point of the temperature coefficient is of the order of 10^{-7} to 10^{-8} per 1°C. It is only this property which makes it possible to achieve effective frequency stabilization by technical means such as a crystal oven, which naturally calls for increased power input. Portable battery - operated oscillators are therefore commonly provided with temperature compensation circuits

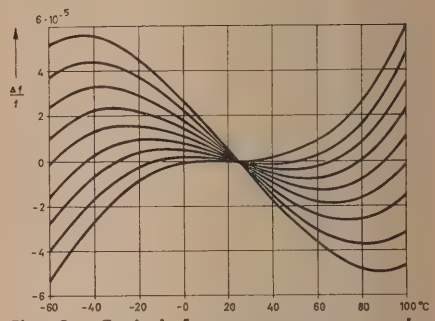

Fig. 2 Typical frequency-temperature dependence of AT quartz crystals with various angles of intersection.

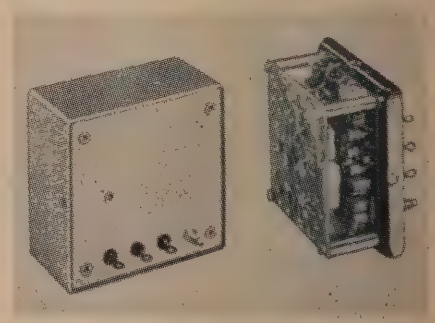

Fig. 3 Crystal oscillators for 1 to 10 MHz. Lower circuit card embodies oscillator circuit, the upper card the temperature control circuit. The TCD with the crystal is arranged betweeen the two. The basic module is 75 mm wide by 78 mm long by 45 mm high.

in which temperature-dependent resistors stabilize the frequency by varying the control voltage of a variable-capacitance diode. In the conventional temperature range the frequency error of crystal oscillators designed in this way remains at best within $\pm1\times10^{-7}$. The frequency deviations resulting from any abrupt change in temperature are, however, several orders of magnitude larger. Quartz crystal oscillators featuring temperature compensation consume very little current (approx. 2mA for compensation) and provide an accurate frequency as soon as they are switched on.

Constructional Features and Properties of the Crystal Oscillator Modules

The crystal oscillators developed by the author's firm make fullest use of the typical frequency accuracy of the quartz crystals mentioned above; they are provided with a Temperature Control Device (TCD) and their accuracy corresponds to the class 10^{-8} (Fig. 3). In order to compensate the frequency deviations due to the temperature coefficient of the circuit, it would be logical to place the frequency-determining circuit elements in the TCD along with the crystal. In the interest of low heating power and short warmup time, however, only the crystal and the frequency-trimming elements are placed in the TCD. The oscillator circuit has to be relatively elaborate in order to minimize the influence of fluctuations in temperature and operating voltage—likewise in the order of 10^{-8}—on the frequency. The oscillator circuit here used features automatic gain control by way of an AGC amplifier suitable for fundamental-mode and overtone crystals of 1 to 10MHz. The TCD is heated by a power transistor, the dissipation (=heating power) of which is automatically controlled by way of a temperature sensor in the form of a thermistor. The decrease in the voltage of the thermistor with temperature represents the instantaneous value in the control system. In order to minimize the influence of the temperature on the crystal frequency, the operating temperature of the TCD is adjusted to the turning point of the temperature coefficient of the crystal.

A second version featuring fast heating—provided by a special temperature control circuit—has been developed to meet professional requirements. Fast heating and normal heating are controlled by way of the same thermistor on a fully electronic basis, i.e. without mechanical contact. The table shows the extremely short warmup times attained. It will further be noted from the table that each type of oscillator requires a crystal with a different approximately constant warmup time after reaching the nominal temperature before the frequency comes to within about 1×10^{-8} of the nominal value. Fast heating consequently first becomes clearly effective at low ambient temperatures (Fig. 4).

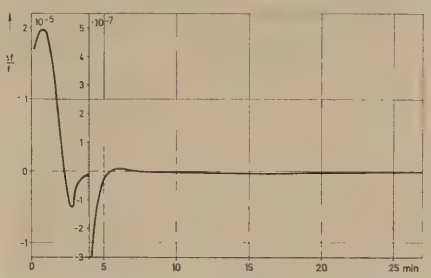

Fig. 4 Frequency characteristic of a crystal oscillator featuring fast heating: 5 MHz, 3rd overtone. The oscillator had been left on the shelf for 12 hours at –28°C before being switched on.

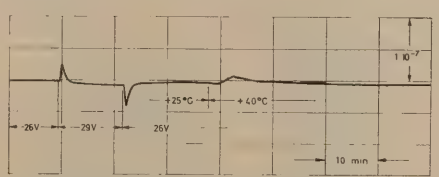

Fig. 5 Influence of fluctuations of operating voltage (left) and of ambient temperature (right) on the frequency of a 5-MHz oscillator.

The crystal frequency may be adjusted with an external trimmer, while an electric frequency-control device allows adjustment with a potentiometer. The frequency output is largely isolated from the oscillator circuit, the frequency response to changes in load between zero and maximum output power being less than 1×10^{-9}.

The 10^{-8} accuracy class requires that the TCD with the crystal circuit and oscillator circuit be supplied as a complete unit. The printed fibreglass circuit board is equipped exclusively with silicon transistors and diodes. Frequency dividers or multipliers may be attached to the crystal oscillator module in order to attain frequencies below or above the 1 to 10MHz range with the same accuracy. The crystal oscillator with its TCD is composed of two circuit cards arranged to form the 45 mm high basic module (see Fig. 3). If frequency dividers, multipliers or power stages are attached, further circuit cards will be added. The height of the basic oscillator module then increases by 15 mm per card. Interposed shields prevent signal transfer between frequency outputs with different frequencies. The frequency dividers embody integrated circuits.

Measurements

The results of measurements made on a 5-MHz oscillator are shown in Fig. 5. The short and relatively large frequency deviations that follow an abrupt change in temperature or voltage are due to the high temperature-gradient sensitivity of the crystal, which may vary with the type and is usually greater with overtone crystals than with fundamental-mode crystals. This influence is, moreover, several times greater with temperature-compensated crystal oscillators and other types without a temperature control device. Its elimination would come relatively expensive and would above all necessitate a considerably longer warmup time. However, since abrupt changes in temperature and voltage are not to be expected in the majority of applications, the resulting frequency deviations are much smaller.

Crystal oscillator module with 5-MHz quartz crystal (3rd overtone)

	Normal heating			Fast heating		
Ambient temperature	–25°C	+22°C	+50°C	–25°C	+22°C	+50°C
Warmup time of TCD	30 min	11 min	2.5 min	2.5 min	80 sec	40 sec
Time up to $\Delta f<2\times10^{-8}$ of nominal value	34 min	14 min	5 min	6 min	5 min	5 min
Current input (E=25V) during warmup time	approx. 140 mA			approx. 1000 mA		
in operating state	100 mA	70 mA	45 mA	150 mA	85 mA	55 mA
Operating temperature range	–35°C–+55°C			–40°C–+70°C		
Δf in this range	$<\pm3+10^{-8}$					

REFERENCES

(1) Guttwein, G.K.: Quartz Crystal R & D—A Status Report. Frequency (1963) No. 5, pp. 14-19.

(2) Pichl, H.: Kurzzeit- und Langzeitkonstanz von Quartz-Frequenznormalen. Rohde & Schwarz-Mitteilungen 15 (1966) No. 20, pp. 244-254.

(3) Handbuch fur Hochfrequenz- und Elektro-Techniker. Vol. II. Verlag fur Radio-Foto-Kinotechnik GmbH, Berlin-Borsigwalde 1953, pp. 160-226.

Television On The Farm

Closed-circuit television — together with other modern devices — is helping the farmer to lower production costs, save staff time, and bring agriculture in line with other modernised fields of industry. Some interesting automatic devices, mainly electronic and electro-mechanical, for the agriculturist, are making their appearance in Britain, bringing the industry to a peak of perfection which is probably higher than anywhere else in the world. At a farm in Sussex, for example, one man can now handle the automatic feeding of 900 pigs, and calves can even be "mothered" automatically. Perhaps the most useful thing on the farm is the closed-circuit television installation which enables the farmer to see — from office, sitting room or bedroom — how his stock is faring. And a modest installation can be had for as little as £250. The ideal application for closed-circuit television, and perhaps the one with most practical value, is for keeping watch on an animal about to give birth; the television equipment allows the farmer or stockman to keep an eye on the "patient" without actually being with it. Other uses allow the farmer to watch feeding animals and poultry, and to keep an eye on a sick animal. Ordinary closed-circuit television, using co-axial cables, is effective up to about ten miles range but improvements are being made in passing television signals over ordinary telephone wires, and this means it will soon be possible to use closed-circuit television over much larger distances.

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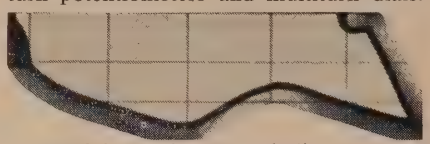

A special continuous winding process is used with automatic measurement of resistance during winding thus giving great accuracy and consistent windings. Military approved. fully guaranteed thev are made in a full range and are available from stock subject to the usual import restrictions.. The diagram shows one of many curves that a Duncan non-linear potentiometer can match.

ENQUIRY 557

"MAGIC EYE" CONTROLS ELECTRIC LIGHTS

A simple electronic device has been developed which controls home and office lighting to give a constant light intensity during fluctuation of daylight.

Developed by a British firm, the device consists of a light control unit with a "magic eye" photo-electric cell. A room's normal on/off switch can be quickly replaced by the control unit, no special wiring or fixing being required.

The photo-cell has a 12ft. cable, which is connected to the control unit by a two-pin plug. A bracket and sucker is used to mount the cell on a window.

When the control unit's selector switch it turned to the "on" position, the "magic eye" will automatically adjust the electric lighting from 12½ per cent to full power, according to the intensity of daylight entering the window.

To convert the device for manual use, a push-button is provided on the control unit. When set for manual use, the selector switch is simply turned to the "on" position and rotated to provide variation in light power.

Four models are available, with lighting loads of 250, 500, 1,000 and 1,500 watts and designed to work on 200/250 volt AC mains. The units can also be used on 110 volts by halving the lighting loads.

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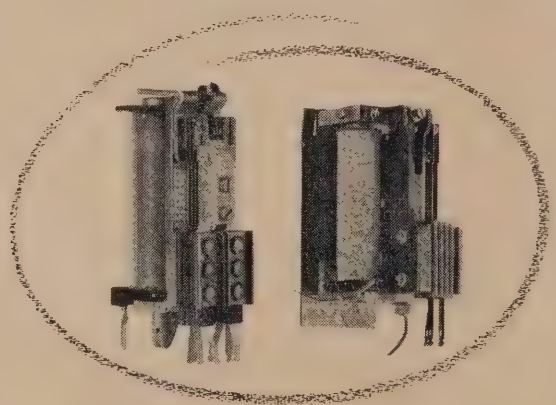

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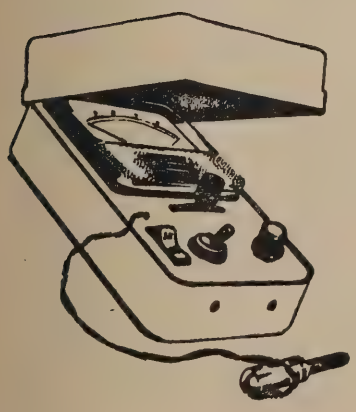

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ENQUIRY 576. USE FORM AT REAR.

Circuit and Service Data

A.W.A. RADIOLA Model PZ32

RADIO RECEIVER

CHASSIS REMOVAL

Remove the control knobs by pulling them straight off their spindles.

Remove the screw holding the small escutcheon on the left hand side of the cabinet.

Open the cabinet back.

The chassis assembly is held in the cabinet by six self tapping screws.

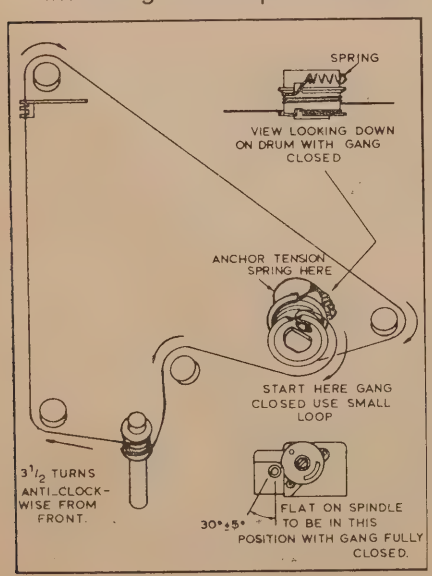
Remove these and lift the chassis to give access to the speaker leads.

Unsolder the speaker leads and the chassis will be free to lift clear of the cabinet.

TUNING METER

The tuning meter is situated in the collector circuit of the r.f. transistor and performs two functions.

1. It indicates battery voltage by indicating collector current with no signal applied to the receiver. Since collector current is dependent only on base bias under these conditions, which is dependent on battery voltage, the latter may be clearly indicated. The meter range is from 9 volts (the thickest part of the red range) to 6 volts (the point of the red range).
2. It serves as a tuning indicator by indicating the drop in collector current due to a.g.c. voltage supplied to the r.f. base. The indicator is quite sensitive so that the meter can be used to tune quite weak stations. The extent to which the needle falls at minimum position is a function of a.g.c. voltage and this may be used as an indicator of station strength.


SPRING
VIEW LOOKING DOWN ON DRUM WITH GANG CLOSED
ANCHOR TENSION SPRING HERE
START HERE GANG CLOSED USE SMALL LOOP
3 1/2 TURNS ANTI-CLOCK-WISE FROM FRONT.
30°±5°
FLAT ON SPINDLE TO BE IN THIS POSITION WITH GANG FULLY CLOSED.

TEST POINT

The collector leads of the output transistors have been left protruding through the circuit board to enable an output indicator to be connected into the circuit without removing the chassis from the cabinet.

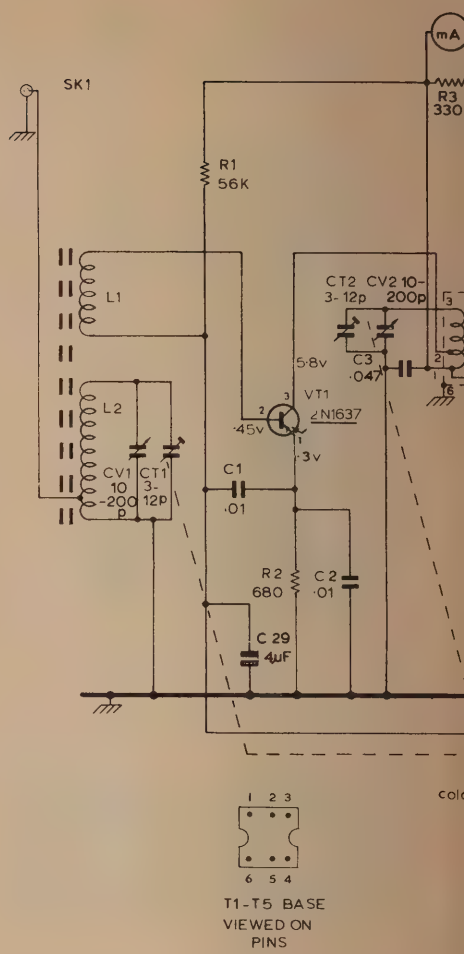
DIAL CORD REPLACEMENT

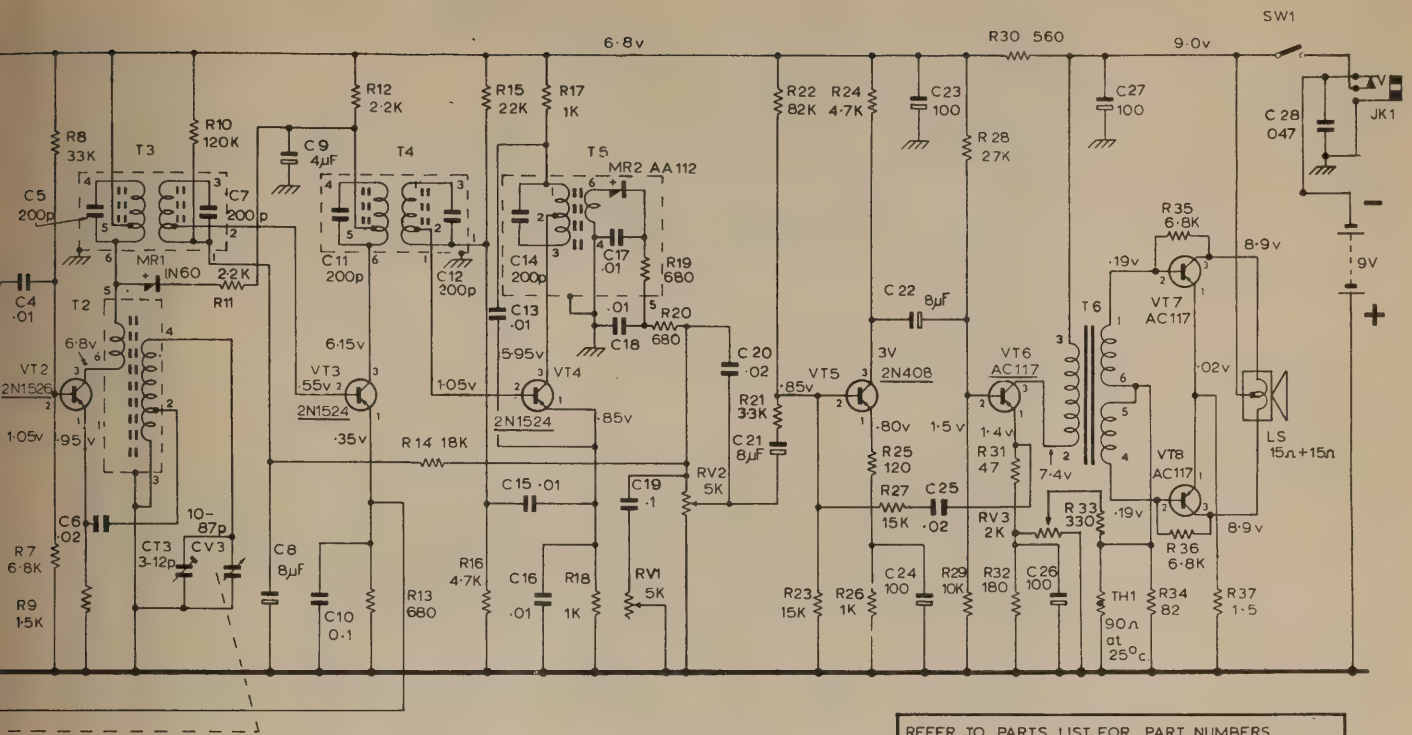
At least 44 inches of dial cord will be necessary for replacement purposes. Commence with the gang closed and the anchor bobbin on the drive spindle as indicated on the dial core layout. Make sure that the cord is fully tensioned before connecting it to the tension spring which is then anchored to the pin remote from the drive spindle. The pointer may now be attached without decreasing the cord tension.

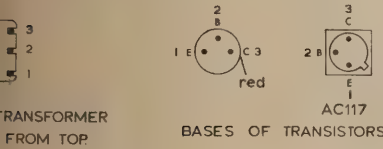
If the drive spindle or gears have been removed for any reason reassembly must conform to that shown on the dial cord layout. The flat on the drive spindle is the important item as this determines the position of the anchor bobbin. The split gears may be 180° out to that shown but the hole in each gear must be in line to provide the correct tension to the anti-backlash spring.

ALIGNMENT INSTRUCTIONS

1. Equipment required:
   (a) A signal generator to cover 450 Kc/s to 1500 Kc/s modulated 30% at 400 or 1000 c.p.s.
   (b) Audio output indicator. No output transformer is used in this receiver, since the speaker has a centre tapped 30Q voice coil and is connected directly to the collectors of the output transistors. To read power output, an A.C. voltmeter presenting an impedance of at least 100Q/volt (i.e. Avo model 8, 10v or preferably 25v A.C. range) with neither probe earthed, connected across the output collectors, will measure the voltage across the 30Q load. The normal alignment level of 500 mw occurs when 3.86v A.C. is indicated on the meter. 2.5 watts corresponds to a level of 8.66v. A.C.
   (c) A non metallic trimming tool suitable for adjusting the I.F.T. and oscillator coil cores.
   (d) A 5.6p.f. capacitor for injecting signals into the tuned aerial circuit and a 6.8K resistor for desensitizing the receiver during R.F. alignment.
2. The signal generator should be switched on at least 15 minutes before beginning alignment.
3. Set the receiver volume control to maximum. During the alignment, the signal input should be adjusted to maintain the output







TRANSFORMER FROM TOP

BASES OF TRANSISTORS.

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at 500mw each time a trimming adjustment is made. The tone control should be set to maximum treble response.

AUDIO CIRCUIT

1. If the output pair of transistors (AC117's) are replaced, readjust the quiescent battery current to 21m.A. under no signal and minimum volume conditions with RV3.
2. Audio sensitivity should be better than 500mW for 45mV to the top of the volume control at 1.0Kc/s.
3. Audio output should be greater than 2.5 watts, total.
4. At 1.0w output total current drain should be 260mA±20mA.

I.F. ALIGNMENT

1. Set signal generator to 455Kc/s and receiver to low frequency end of band. Inject the I.F. signal into the base of the converter. Stop the local oscillator by shorting the tuned section at the oscillator trimmer to earth.
2. Tune 3rd I.F.T. to peak nearest circuit board.
3. Tune primary and secondary of 2nd I.F.T. to outer peaks.
4. Screw the primary (lower) core of the 1st I.F.T. right out. Tune the secondary (upper) core to the outer peak and then peak the primary winding on the outer peak. Do not readjust secondary.

R.F. ALIGNMENT

Temporarily desensitise the receiver by connecting a 6.8KQ resistor between the junction of R14 and C8 to chassis.

Connect signal generator via a 5.6pf capacitor to the aerial tap on the tuned aerial coil winding.

1. Check that when the gang is fully meshed, the pointer lines with the datum mark at the low frequency end of the scale, between the figures '2' and '3'.
2. Adjust the oscillator coil (T2) core at 600Kc/s and oscillator trimmer (CT3) at 1500 Kc/s for max. response.
3. Adjust the R.F. transformer (T1) core at 600 Kc/s and R.F. and aerial trimmers (CT2 and CT1) at 1500 Kc/s for max. response.
4. The inductance of the ferrite rod is accurately set by the manufacturers and will not require any adjustment provided the previous operations are correctly executed. However, if the aerial circuit appears to be considerably out of alignment (3db or more) at any of the tracking frequencies, indicated by a rise in output with a change of aerial coil inductance, then the aerial coil has either shorted turns, or become open circuited. The whole assembly should then be replaced. Coil inductance will be effectively decreased by a shorted turn of wire placed over one end of the rod and increased by bringing a further piece of ferrite material up close to the rod.
5. Check alignment at 1000 Kc/s.

D.C. RESISTANCE

T1 R.F. coil 1-3 7.0Q, 1-2 0.8Q, 1-4 0.5Q
T2 Osc. coil 3-4 4.3Q, 3-2 0.2Q, 5-6 0.5Q
T3 T4 1st & 2nd I.F. 1-3 9.7Q, 1-2 0.7Q, 6-5 2.5Q, 6-4 9.7Q
T5 3rd I.F. 3-2 6.1Q, 3-1 9.6Q, 4-6 1.7Q
T6 Driver transformer 2-3 235Q, 1-6 35Q, 4-5 35Q

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ENQUIRY 639. USE FORM AT REAR.

R.F. SIGNAL SOURCE IMPEDANCE.

By J. F. Golding*

The accuracy of the match between a signal generator's output impedance and its connecting cable is usually expressed in terms of v.s.w.r. Although such terms have real significance, a clear understanding of the electrical behaviour is necessary if the figure is to be applied as a measure of the ultimate accuracy of the output circuit.

Figure 1: A correctly terminated cable. Zl=Zo

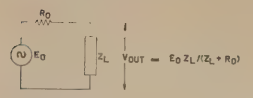


Figure 2: The equivalent network for Fig. 1.

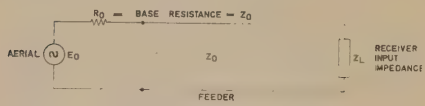


Figure 3: The equivalent circuit of an ideal aerial. Eo=Field strength × effective height.

Nowadays the performance specification of a good quality signal generator usually contains a statement of nominal source impedance and the voltage standing wave ratio—or v.s.w.r. Taken literally, such a statement is not very meaningful; because, although standing waves can appear over the length of a transmission line or waveguide, they can hardly exist at a single point, such as the output terminal of a signal generator.

In this context, however, the v.s.w.r. figure is really a measure of the accuracy of the stated source impedance. It may be defined as the ratio between the voltage at the antinodes and that at the nodes of the standing wave that would appear on a loss-free line, of characteristic impedance R, terminated by the signal generator (i.e., when the signal generator's source impedance is the load). Ro is the nominal source impedance of the signal generator.

In theory, a statement of v.s.w.r. alone is insufficient information for calculation of the actual source impedance; for we also need to know the position of the nodes, in terms of line wavelength, relative to the termination.

In practice, however, we are not so concerned with the fairly small errors in source impedance as with errors in the voltage that the signal generator produces across a load at the receiving end of the cable. So we can regard the statement of v.s.w.r. as a way of expressing the limits of variation in the ultimate output due to unwanted standing waves.

*Marconi Instruments Ltd. St Albans, England.

The Behaviour of the Link

If the output cable of a signal generator is terminated in its characteristic impedance at the receiving end, as shown in figure 1, all the power will be absorbed in the terminating resistance, and no standing waves will occur regardless of the source impedance. Furthermore, the impedance of the cable at the sending end will be equal to its characteristic impedance, so that, neglecting loss in the cable, Vout = Vin = EoRo/Zo + Ro; and the overall behaviour will be equivalent to that of the network in Figure 2.

But, when a signal generator is used for testing a receiver, the connecting cable is unlikely to be correctly terminated. Although a receiver may be intended for use with an aerial having a particular impedance, the input impedance of the receiver has no fixed relationship with either the aerial impedance or the impedance of the feeder line.

At frequencies above about 5 MHz, resonant aerials are often used, the dimensions of the aerial being adjusted so that it correctly matches a feeder of standard impedance. This principle is sometimes applied somewhat loosely in the h.f. band; but, at v.h.f. and u.h.f. the aerial is almost invariably matched to 50Ω, 60Ω, or 70Ωcoaxial (unbalanced) transmission line or to 300Ω (balanced) ribbon feeder.

For assessment of a receiver's performance, it is assumed that it is to be used with an ideal aerial of specified impedance. The equivalent circuit of such an aerial is shown in figure 3; and the output circuit of the signal generator used to test the receiver must be such that the instrument simulates the conditions shown in the diagram.

If ZL, the input impedance of the receiver, does not equal Zo, the characteristic impedance of the cable, some power must be reflected back to the source. But, as the source impedance, Ro, terminates the cable correctly, this power will be totally absorbed, so that no further reflection will occur. By definition, when the source impedance exactly matches the cable the system has a **v.s.w.r. of unity.** Nevertheless, there is bound to be a standing wave present due to the reflection from the receiving end.

The significance of the v.s.w.r. figure stems from the fact that, when the cable is correctly terminated at the sending end by Ro, the phase and magnitude of the voltage developed across Ro by the reflected power exactly matches the effect of the standing wave. The e.m.f. and source impedance at the receiving end of the cable are, therefore, exactly equal to the e.m.f. and source impedance at the sending end. A complete explanation of this effect has been given by Flanagan (1); but we can take as an illustration the example of a quarter-wavelength cable fed from a matched source as shown in figure 4.

A quarter-wave transmission line which is open-circuit at the receiving end (figure 4a) presents a short-circuit at the sending end, and the output voltage, Vout, is equal to IinZo. Providing the source impedance, Ro, is equal to Zo, Iin = Eo/Zo, and Vout is equal to Eo. With

the cable correctly terminated (figure 4b), Vin = Vout = Eo.Zo/Ro + Zo, which is Eo/2 when Ro = Zo. And in the case of a short-circuit termination, as shown in figure 4c, the cable presents an open circuit at the sending end, with the output current, Iout, equal to Vin/Zo. As Vin must be equal to Eo, the output current is Eo/Ro.

The voltage and current conditions at the receiving end of the cable are, thus, identical to those that would occur if the cable were omitted and the measurements made directly at the source. So there is effectively an "image source" at the receiving end of the cable, which is an exact facsimile of the real source at the sending end.

This is, of course, a special case. To show that the image source appears in the same way for any length of cable we start by considering the effect of an open-circuit transmission line fed from a source impedance Ro, equal to Zo (figure 5). Depending on the length of the line, the input impedance will vary from zero at odd quarter wavelengths to infinity at even quarter wavelengths, so that the input voltage, Vin, will vary from zero to Eo.

A general expression for output e.m.f. of the open-circuit line is

$$Eout = Vin/\cos\beta d, \quad (1)$$

where d is the length of the cable and β is the phase constant of the cable ($\beta = 2\pi d/\lambda$).

As $\cos\beta d$ can never exceed unity, the line behaves as a voltage step-up transformer. The input voltage is, of course, given by

$$Vin = Eo.Zin/(Zin+Ro). \quad (2)$$

where Zin is the cable's input impedance.

From transmission line theory, $Zin = -jZo \cot\beta d$, and it can be shown that, when Ro = Zo,

$$Zin/(Zin+Ro) = \cos\beta d. \quad (3)$$

The open circuit output voltage is, therefore, given by

$$Eout = Eo \cos\beta d/\cos\beta d = Eo.$$

So the e.m.f. of the image source is equal to the e.m.f. of the real source regardless of the length of the cable. As the cable is terminated at the sending end in its characteristic impedance, it is bound

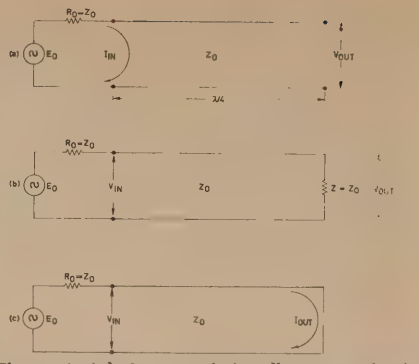


Figure 4: (a) A transmission line open-circuit at the receiving end. (b) Correctly terminated transmission line. (c) Short-circuit at the receiving end.

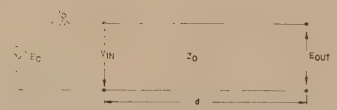


Figure 5: Open-circuit transmission line with Ro=Zo.

to present this impedance at the sending end—i.e., looking back into the line with Eo set to zero. By Thevenin's theorem, therefore, the source impedance at the receiving end is again equal to Ro.

The Voltage Error

Of course, all the above arguments can be applied whether the source is the ideal aerial or a signal generator. But they are true only if the v.s.w.r. is equal to unity. The ideal signal generator, however, is just as hypothetical as the ideal aerial; the v.s.w.r. will not be equal to unity in practice; and our aim must be to assess the maximum measurement error due to any given standing-wave-ratio.

The e.m.f. of the image source for any length of cable is the voltage output when the receiving end is open-circuit. This is given by the general formula:

$$Eout = \frac{jEo}{\cos\beta d + j(Zsg/Zo)\sin\beta d} \quad (4)$$

where Zsg is the actual source impedance of the signal generator.

It is obvious that maximum e.m.f. error must occur when the denominator of (4) is farthest from unity. For values of βd equivalent to 0, 180°, etc. (i.e., even quarter wavelengths) the denominator is equal to 1, so that Eout = Eo, and the error in e.m.f. is zero. Values of βd equivalent to 90°, 270°, etc. (odd quarter wavelengths), however, give output voltages of

$$Eout = jEo/j\left(\frac{Zsg}{Zo}\right) = Eo.Zo/Zsg, \quad (5)$$

and this is the condition for maximum error.

But, if the v.s.w.r. is in terms of Vmax/Vmin,

$$Zo/Zsg = \frac{S+j\tan\phi}{1+jS\tan\phi}$$

where S is the v.s.w.r.
and ϕ is the angular displacement of the first voltage node from the end of the line.

The phase displacement, ϕ, occurs when Zsg is a complex impedance of the form R+jX; and the value of $\tan\phi$ can vary from zero to infinity for any given value of S. As this phase displacement does not normally appear in the signal generator's specification, we have no way of assessing its effect from the v.s.w.r. information given. We are, however, concerned with assessing the maximum error for the stated v.s.w.r., and this occurs when ϕ is equal to 0° or 90°. When ϕ=0, Zo/Zsg=S, and when ϕ=90°, Zo/Zsg=1/S; but for intermediate values of ϕ the error decreases to the point where ϕ=45° and Zo/Zsg = 1.

So we find that the maximum error in e.m.f. occurs when Zsg is purely resistive, the factor of error then being equal to the v.s.w.r. In practice, the standing-wave-ratio is, nearly always, at least partly due to some series or parallel reactance; so we might reason that the maximum e.m.f. error is seldom realised. The reactive components of the source impedance, however, are unlikely to be simple; series and paralled capacitive and inductive components are likely to be present, so that a number of resonance modes are likely to be encountered within the frequency range of the signal generator. The value of ϕ is, thus, certain to vary with frequency and may well pass through 0 or 90°.

To avoid any possible confusion, let us make it quite clear that the value of ϕ is totally unrelated to the cable length for maximum error. This occurs at frequencies where the cable is equal to an odd number of quarter wavelengths regardless of the phase angle of the source impedance.

The impedance of the image source is again found by application of Thevenin's theorem, and is equal to the line impedance at distance d from Zsg. Assuming a loss free line, and calling this line impedance Zs, we have, from transmission line theory,

$$Zs = Zo \frac{Zsg + jZo \tan\beta d}{Zo + jZsg \tan\beta d} \quad (6)$$

For a cable length such that βd is equivalent to 90°, where maximum e.m.f. error occurs, we also have a maximum impedance error; i.e., $Zs = Zo^2/Zsg$. But we also have another maximum when βd is equivalent to 0°, 180°, etc., where the output e.m.f. error is zero. The output impedance at these points is, of course, Zsg

So we can summarise the maximum possible error due to standing waves for any given v.s.w.r. as follows:

If the cable is an odd number of quarter wavelengths, the image source is as shown in figure 6. The limits of e.m.f. error are

$$Eout = Eo + Eo(S - 1)$$

or

$$Eout = Eo - Eo(1 - 1/S),$$

which, if the v.s.w.r. is close to unity, is very nearly equal to

$$Eo \pm Eo(S - 1).$$

Similarly, if the v.s.w.r. is close to unity, the limits of impedance error are

$$Zo \pm Zo(S - 1).$$

If the cable is an even number of quarter wavelengths the image source is a fascimile of the real source so that Eout=Eo, but the source impedance, Zsg, may be in error to the limit given by Zo±Zo (S—1).

Two further facts are apparent regarding the voltage accuracy. A statement of nominal source impedance and v.s.w.r. gives no indication of the direction of the error in source impedance. And, although the image e.m.f. error falls to zero at even quarter wavelengths, the impedance error must produce an error in the final output voltage when a finite impedance load is connected. Moreover, even when the cable is correctly terminated at the receiving end, so that no standing wave is present, the actual voltage across the load is not Eo/2 but Eo.Zo/Zsg+Zo, which, in the worst case, is Eo/2±Eo(E—1)/2.

Practical Considerations

The absolute voltage accuracy of a signal generator is mainly relevant to such measurements as those of sensitivity or low-level response; and it is generally regarded as being quite acceptable to restrict the specified v.s.w.r. to the lower output voltage settings of the signal generator's attenuator. However, as the requirements of receivers become more stringent, higher standards of accuracy are needed in measurement of rejection ratio or spurious responses, where the signal generator may be used at settings approaching its maximum output.

Restriction of the specified v.s.w.r. to output levels up to 20 dB below maximum output carries a generally accepted implication that this aspect of the instrument's performance deteriorates over the highest voltage decade. But this is only true in certain circumstances; for, although the output impedance may appear to be seriously in error when measured by an r.f. bridge or the standing-wave-ratio method, the error in the actual test voltage is not necessarily significantly greater at maximum output than at the lower levels.

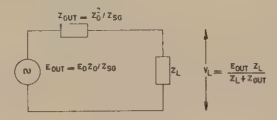


Figure 6: Equivalent circuit (image source) when cable length=(λ/4)×n where n is an odd integer.

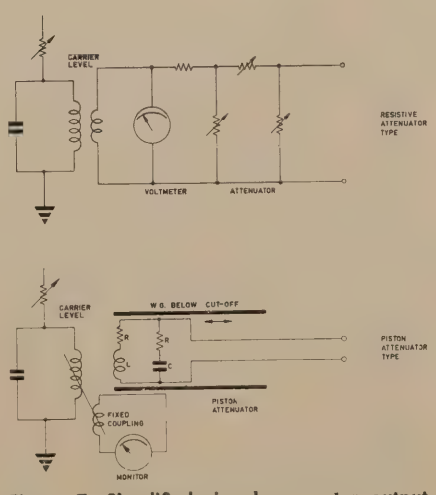


Figure 7: Simplified signal generator output circuit.

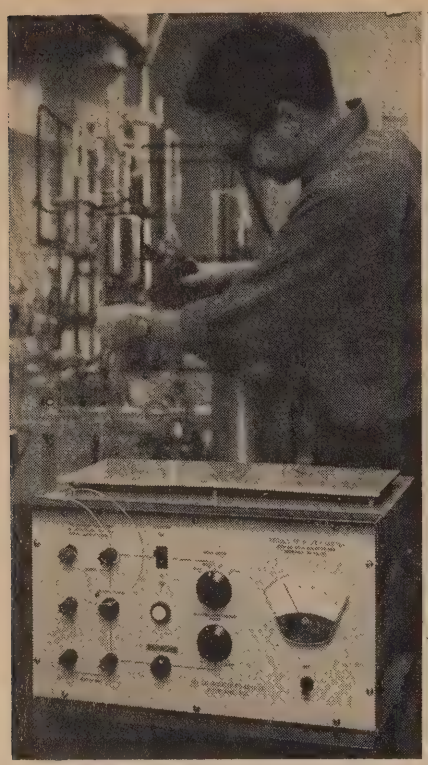
Modern signal generator output circuits usually take the form shown in figure 7, where the carrier level from the r.f. generator is monitored by means of a diode voltmeter before application to a constant impedance variable attenuator. Providing the attenuation exceeds about 20 dB, the r.f. source is effectively isolated from the output socket, and the source impedance of the signal generator is virtually the output impedance of the attenuator. At the small attenuation settings required for high output levels, however, this isolation disappears; and the output circuit behaves in the manner of the equivalent network shown in figure 8, in which Z_1 is the effective impedance of the r.f. source.

It is obvious that, if we stop the oscillator and measure the impedance looking back into the output circuit in the conventional way, we shall get a v.s.w.r. figure that is far from unity. But, when the signal generator is in use, the potential drop across Z_1 is compensated for by adjustment of the carrier level control to produce the correct reference indication on the monitor. It is, in fact, the voltage across the monitor that must be regarded as Eo.

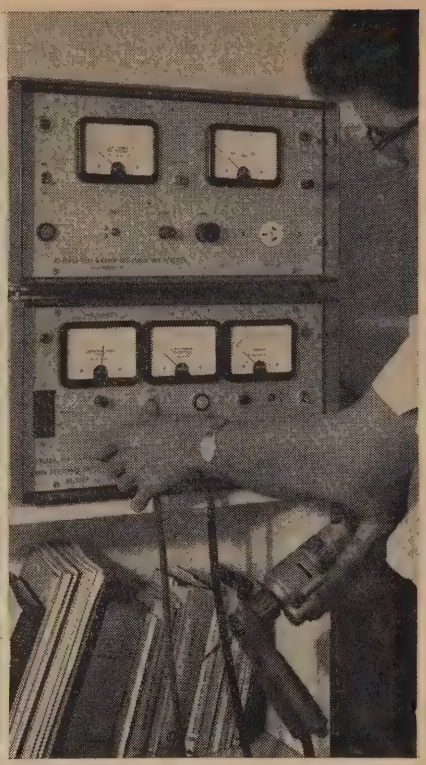
The actual standing wave conditions on the cable—and, hence, its input impedance—are determined solely by the load impedance and the cable length; they are not influenced by the source impedance at all. Therefore, providing the appropriate carrier level correction is made for any change in load impedance, the image source at the receiving end of the cable will retain the form giving $VL = EoRo/Ro+Z_1$ for all attenuator settings.

Good quality signal generators now usually include an effective automatic level control (a.l.c.) system, so that the correction is made automatically, and the dynamic impedance of the internal r.f. source is very low indeed.

The effective v.s.w.r. with small attenuation settings (high output)



A regulated power supply instrument built for the Auckland University.



Flash Test and Earth Resistance Unit for safety check to N.Z. Standard Specifications of home appliances.

Calibrating Panel for Simmerstat Energy regulators in production.

getting down to SPECIFICS

YOU NEED Ai CUSTOM-BUILT ELECTRICAL TEST EQUIPMENT

Allied Industries are manufacturers of Electrical Test Equipment. But it's a special kind of equipment — it gets right down to specifics. A.I. custom build Test Instruments and Equipment to meet their client's precise requirements — unnecessary circuitry or features are not incorporated.

For instance, an Auckland home appliance manufacturer uses an A.I. Flash Test and Earth Resistance Unit as a safety check on circuitry while yet another uses an A.I. designed Calibrating Panel to ensure performance standards in Simmerstats. The Auckland University have installed Regulated Power Supply Instruments for laboratory experiments.

The advantages of A.I. custom-built Test Equipment are, at once, obvious.

Are you guessing instead of measuring — chancing instead of testing? Why not seek the aid of A.I.'s specialist services and have them design and build Test Equipment that enables you to set and maintain standards. Your enquiry will receive prompt attention.

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AI.3.

ENQUIRY 578. USE FORM AT REAR.

could, therefore, be measured by conventional methods if a short circuit were placed across the monitor before the measurement. The v.s.w.r. figure obtained in this way would certainly be valid for assessing the possible voltage error due to source impedance. It might not, however, be a true measure of the impedance that the signal generator would present, while in operation, to an external source; e.g., a second signal generator used for two-signal tests on a receiver.

It is therefore important, when using two signal generators in this way, to make due allowance for a possible mismatch, which would affect the voltage applied to the receiver by the "low-level" signal generator—not the one giving near maximum output.

Measuring Effective V.S.W.R.

In the future, manufacturers may specify a figure for the effective equivalent v.s.w.r. at high signal generator output levels; but this is not common practice at the present time. A reliable method of measurement using the signal generator itself as the test signal source is, therefore, likely to be of interest to engineers concerned with measurements on high performance receivers.

We established earlier in the article that the maximum e.m.f. error for a given v.s.w.r. occurs when the source impedance is resistive so that $Zo/Zsg = S$ or $1/S$. And, for most practical purposes, it is the ratio Zo/Zsg that we need to know rather than the v.s.w.r. alone.

A successful method, devised by Parkyn (2), is based on measurement of the short-circuit current at the receiving end of a cable at odd and even quarter wavelengths.

The test equipment required is an adjustable line having a characteristic impedance equal to the nominal source impedance of the signal generator and a suitable current monitor.

The slow response and comparatively high heater resistance of a thermocouple precludes its use for measurement of the current; but satisfactory results can be obtained by measuring the small voltage developed across a thick radial wire fitted into a terminating connector to short the coaxial inner to the

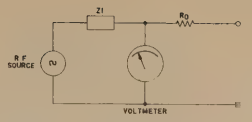


Figure 8: Equivalent circuit of figure 7.

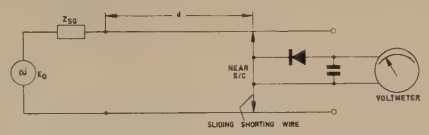


Figure 9: Circuit arrangement of sliding short set up.

Describing the use of standing-wave-ratio as a measure of source impedance accuracy of signal generators at frequencies between 5 and 1000 MHz.

outer conductor. The voltage detector must, of course, be as close to this near short circuit as possible; and in the experimental set up a silicon diode was also mounted in the terminating connector, giving the overall circuit arrangement shown in figure 9.

When the line length is adjusted to be a half wavelength—i.e., $d=\lambda/2$ — a reflected short circuit appears at the sending end, so that the input current, I_1, equals Eo/Zsg. With a loss free line, an equal current will be measured in the short circuit $\lambda/2$ away. With the line readjusted to a length of $\lambda/4$, an open circuit will be reflected from the short circuit termination, so that the input voltage, Vin, will be equal to Eo. The short-circuit current at the receiving end, I_2, is given by, $I_2 = Vin/Zo = Eo/Zo$. Thus $I_1/I_2 = Zo/Zsg$, which is the ratio we require for calculating the e.m.f. error, and, if Zsg is resistive, is equal to the v.s.w.r.

The information obtained by this method is, in some ways, more useful than an actual v.s.w.r. figure for assessing the maximum error—although the phase angle information, which would give the true source impedance, is again missing.

Measurements made by this method in the laboratories on a number of signal generators showed that the impedance ratio at near maximum output does not deteriorate significantly from the v.s.w.r. at lower output levels. Tests were made at frequencies up to 1 GHz and it was found that the principle can be applied to instruments having either resistive or piston type attenuators, similar results being obtained for the two forms.

New Lasers For Precision Measurement

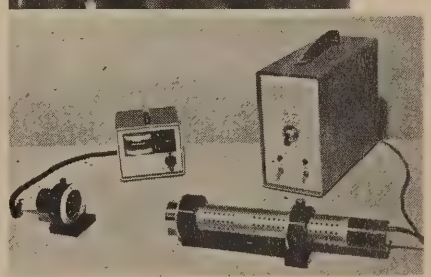
The tooling laser, used in conjunction with a centering detector, provides the fastest and most accurate method of monitoring mal-alignment yet available to industry. It is expected to find widespread application in machine tooling, aircraft construction, civil engineering, shipbuilding and research industries where a precise straight line is essential to equipment or surface alignment.

In the system a beam from a helium-neon gas laser is detected by the centering device which gives an immediate digital readout of mal-alignment to a precision of .002" in 200ft.

Main application of the laser interferometer—which measures linear displacement to a precision of two millionths of an inch—will be in the machine tool industry.

The system, which depends on the measurement of light fringe numbers between the laser and a retro-reflector, will cost a third less than other laser interferometers.

ENQUIRY 614



Top:
Pilkington Perkin-Elmer's laser interferometer. A beam from the laser (right) is returned from the retro-reflector (left) to the interferometer contained in the laser housing and linear displacement is indicated on a digital counter.

Bottom:
Pilkington Perkin-Elmer's new tooling laser system. The laser (right foreground) with its associated supply, emits a beam to the centering detector (left foreground) which provides an immediate digital read out mal-alignment on the indicator.

REFERENCES:

1. **Signal Generator Outputs by T. P. Flanagan, Marconi Instrumentation vol 4, p 105, March 1954.**
2. **Signal Generators—Source Impedance or Output Impedance, by J. M. Parkyn, Marconi Instrumentation, vol. 10, p 66, May 1966.**

HI - FI for mini-money

by B. M. Terry, A.I.E.R.E.*

The construction of the amplifier is relatively simple and "bug" free if the layout as illustrated in the first article is followed.

*Audio Centre Ltd., 67 Wakefield St., Auckland.

As this illustration shows most of the components are mounted on 10 way tag strips towards the left end of the chassis looking from the rear and upside down. Before assembling components to the strips lay the strips in the chassis approximately 1/8" from the back and front and 1½" from the left hand end. Mark the mounting hole positions which are then later to be drilled 1/8". Arrange the tube sockets as shown with their mounting lugs at 45 degrees clockwise and mark. The order of layout is as follows. The two sockets nearer the front of the chassis are the two ECC83 the three near you are ELL80 ECC82 ELL80. The position of the rectifier valve socket and the 40 + 40 + 20 filter block in relationship to the power transformer which is mounted hard back in the corner is easily discernable.

Nine oneEone standoffs, i.e. 2 live with one earth mount, are used for mounting various components, the earth lug on all but one, being folded down to keep it clear, the unfolded one being mounted by a socket hole bolt at the pre amp valve VI. This unfolded earth lug is used as an earth return for the two 2 megohm grid input resistors and is the only point where components are earthed to the chassis. All others are connected to a twin twisted 18 gauge tinned copper bus bar.

LISTENING POST

By Bob Harmer.

All times in G.M.T. and frequencies in kilocycles.

SOUTH AFRICA

Radio R.S.A. schedule of English language transmissions are as follows:

To **Canada and U.S.A.** from 2330 — 0325 on 11875 and 9705.

To **Europe** from 1900 — 1955 on 21500 and 17790. The station also broadcasts news bulletins to Africa from 0415 — 0427 on 15220 and 11900, 0430 — 0442 on 17805 and 15220, 0500 — 0512 on 11900 and 9525, 0515 — 0527 on 21535 and 17805, 0645 — 0657 on 17805 and 15220, 1600 — 1655 on 15220 and 11900, 1700 — 1755 on 21535 and 17805 and 2100 — 2155 on 21535 and 17805.

AUSTRIA

The Austrian Shortwave Service has been heard at good level at 0500 on 6155 and 17855. The Station identifies in English and German but the main programme is in German.

GERMANY

Deueches Welle, the Voice of Germany is giving good signals at 0445 on 9545 when an English language broadcast is beamed to North America.

PORTUGAL

The Voice of the West, transmitted from Lisbon to North America is consistently good from 0345 — 0430 on 6025 and 6185.

RADIO MOSCOW

Uses the frequencies of 15140, 11690, 9750, 15140, 11690 and 9540 for English language transmissions which may be heard in Australia and New Zealand. The Station's North American transmission on 9480 is also heard at good signal level from 0200 — 0230.

JAPAN

The American Forces Far Eastern Network is heard at 0900.

PHILLIPPINES

The Philippine Broadcasting Service's transmitter D.U.H.2 is heard around 1100 with an English language broadcast including news and sports items. The frequency is 6170.

HOLLAND

The latest information from Radio Nederland gives their English language transmission as follows:

To Australia and New Zealand	—	0730 — 0820
To South Asia	—	1430 — 1520
To Africa and Europe	—	1900 — 1950
To Europe only	—	2000 — 2050
To Europe and North America	—	2100 — 2150
To West Africa (relay from Bonaire)		2130 — 2220
To Nth America (relay from Bonaire)		0130 — 0230

Frequencies in use for these transmissions are:— 5980, 6020, 6085, 9525, 9590, 9715, 11730, 11970, 15220, 15425, 17775, 17810, 21480, 21570 and 25610.

NEW CALEDONIA

Radio Noumea is heard at 0900 in French on 3355.

SOLOMON ISLANDS

The Solomon Island's Broadcasting Service at Honaira is on the air in English daily. The signal on 3995 is consistently good in the evenings until close down around 1130.

many other factors to consider that it is well to stick to the designer's instructions—he has already poured out his "blood, sweat and tears" for your benefit.

Looking at the illustration these stand off tags can be located at the input valve socket, next to support the .05 coupling condensers which are fed through a twin twist insulated lead to one mounted on the end of the pre amp board and support the two 220K resistors connected to the bass control and the two 470pf condensers to the treble control.

The next tag supports the 8mfd filter condenser and resistor followed by another for the L.T. filament leads and the two 47ohm resistors across this winding.

Two more are shown mounted by their own screws, not the socket screws, between the ELL80s and the ECC82 to support the four coupling condensers and grid stoppers of the ELL80s. The last two next the output terminals support the feed back resistors and condensers.

The 6.3 volt output of the transformer is common to all valves, a two colour 10/010 tightly twisted lead connects to the appropriate valve pins. Keep the same colour to the corresponding pins on each socket.

The layout of the ten way boards is illustrated and it will be apparent where the high stability resistors are used. Watch polarity of the electrolytics.

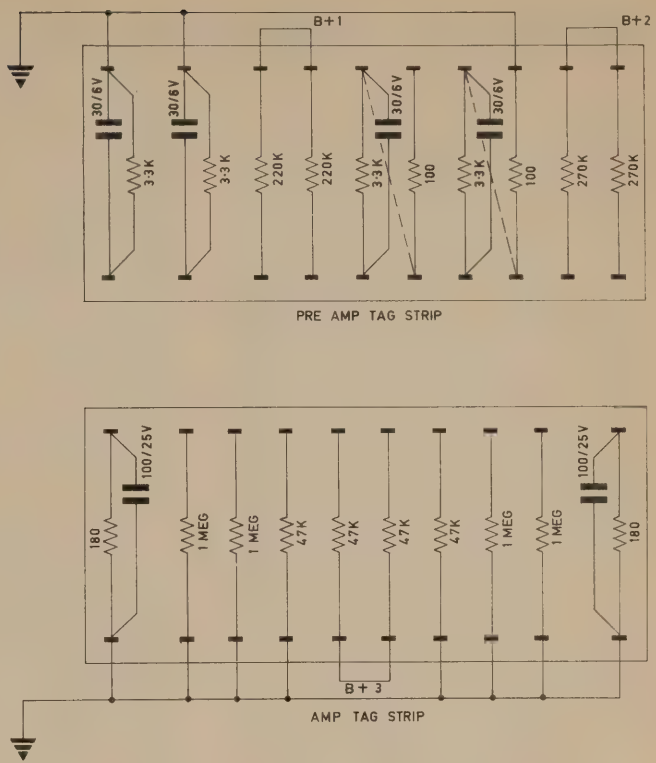
It is not a bad idea to give the signal leads of each channel their own colour, in our case we used white and green so that when checking the wiring the channel can be traced right through from input to output.

The layout lends itself to extremely short leads which of course reduce stray capacity and the single earth points in combination with the heavy bus keeps hum fields and earth loops to a minimum. The longest signal leads are from the volume control back to the grids of V2 and there is no need for co-axial cable here, provided three 10/010 leads are twisted—two of them signal leads and the third the earth which is connected to the socket spigot, which in turn is connected to the bus bar passing over it .

The amplifier is mounted on a standard Fryco 12 x 8 x 2 aluminium chassis with base. Having purchased it go ahead laying it out and mounting the components. The output transformers are wired according to the manufacturer's instructions for the output impedance required for your speakers, one side of the secondary being earthed, the other going to the tag strip supporting the feed back resistor and of course the speaker terminals.

As we have mentioned in the earlier article the output transformers are an integral part of the amplifier and those specified MUST be used. This does not mean that there are no other suitable transformers that would work, but a good deal of the circuit parameters are tied up with the specifications of the recommended transformers and unless you have available a square wave generator and an oscilloscope and know how to interpret what you see and adjust the various components accordingly, follow our advice.

After all we did not design this amplifier in five minutes and it took us a little longer to get its performance to our satisfaction. Always remember **a circuit does not make an amplifier** and there are so



Having completed the wiring with the exception of the feed back resistor-condenser combinations, leave these out meanwhile, and having checked your efforts against the circuit and illustrations you are ready to "light up.'

Connect the speakers and turn the volume control up slightly so that the signal source is just audible, now apply the feed back resistor by placing its leads across the terminals very briefly. The signal should drop in the speakers. If an ear shattering "swark" greets your efforts you have positive feedback instead of negative. This being the case reverse the earth and live leads on the output transformer **secondry** and try again. If all is well, solder the components in place and you are ready to enjoy your equipment.

Next we will deal with some "mini money" forms of speaker enclosures and speakers suitable for the amplifier that not only do justice to it but to themselves.

LIST OF COMPONENTS AND SOURCE OF SUPPLY

Front panel 12¼ x 5¼ 20 G Ali. } Fryco Products
Chassis 12 x 8 x 2 with base }

Output Transformers 15 Watt Hi-Line } Waldo Hunter Ltd.
ELL 80 Telefunken }

Power Transformer 280v + 280v at 100 M/A 6.3v at 4A
Beacon Radio and most Wholesalers.

High Stability Resistors — Philips or Erie, Turnbull & Jones Ltd.

Balance Control — Philips.

All other components are standard; use good material.

NEW PRODUCTS REVIEW

CIR-KIT

This completely new development in making printed circuits is claimed to be superior to other methods of making prototypes or short runs of any type of electronic circuit. "CIR-KIT" consists of pure copper strip coated with a special adhesive which will withstand heat. Strip is cut to length and placed on insulating material such as paxolin board and laid out in the shape of the circuit required. Holes can be punched or drilled as required to take components and any circuit can be built up quickly and easily.
ENQUIRY 556

ILLUMINATED PUSHBUTTONS

The 01-700 series of momentary one-light pushbutton switches, made under licence in England from the Licon Division, Illinois Tool Works Inc., have double-break switch action.

The switch unit is rated at 10 A 250 V a.c. or 28 V d.c. The screw based bulbs are suitable for 6, 12 or 28 V operation and can be replaced from the front of the panel. The units are available with cylindrical translucent lens caps or standard 01 series round or square caps in seven colours. **ENQUIRY 660**

COUNTING CONTROL SYSTEM

An electro-mechanical counter for specialised digital count/control or timer operations is now available in the UK.

Known as the 49600 Unisystem, it has been specifically designed for application on machine tools, textile machinery, wire machinery, and metering and scaling equipment. It is available as a cabinet or for panel mounting in two-, three- or four-digit predetermining and count levels. Simple adjustments in the rear panel wiring allow one unit to be custom-wired for the user's choice of one of eight different operational controls. The instrument is driven by pulse generating sensing devices and has a count speed of 30 per second. Preset values are retained even in the event of a power failure. Reset can be made either at the panel or by remote control. Standard models are available for 115 or 230 V 50/60 c/s operation. **ENQUIRY 661**

INFRA-RED BEAM INTRUDER DETECTORS

There are three different types of intra-red beams available in the Photain range of intruder detectors.

Each system uses silicon solar cells as the photoelectric detector, since these are highly sensitive in the infra-red range of the spectrum and are capable of working at high temperatures without detrimental effects. The projector, receiver and control housings are common to all types.

Supply voltage is 110/200/250 V 50/60 c/s with provision for standby battery supply if required. The direct beam type BB has a low voltage lamp in the projector which emits the beam through an infra-red filter. The range of beam lengths available is from 10 to 100ft. The modulated beam type MB has a switched lamp supply, operating at about 2 kc/s. The lamp voltage automatically varies with the beam length and is always considerably below the lamp rating, thus ensuring long lamp life and providing automatic compensation for poor atmospheric conditions.

With a modulated beam, all other forms of light are "ignored." The laser beam type LB, consists of an infra-red emitting diode with indefinite life which is pulsed to give a modulated beam with a high power output. **ENQUIRY 662**

MOISTURE RESISTING ENCAPSULANT

A family of polyurethane resins, which are claimed to combine excellent moisture resistance, electrical properties and long shelf life, has been developed by an American company.

Scotchcast polyurethanes are low viscosity, low exotherm resins, having good thermal shock resistance and low stress at low temperatures. They provide a tough abrasion resistant coating which can be repaired, and are said to overcome the problems of the older polyurethane systems, which were toxic, hard to handle and unstable. The resins are suit-

ENQUIRY 356. USE FORM AT REAR.

THE NEW ZEALAND ELECTRONICS INSTITUTE (Inc.)

Below we list the principal officers of the Institute and the addresses of the three Branches from each of which details of Institute Membership can be obtained:

Dominion Headquarters:
P.O. Box 1506, Christchurch.

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Mr. J. L. McKie, A.P.A.N.Z., A.I.A.N.Z.

New Zealand President:
Mr. J. P. Senior.

Council:
Messrs. B. D. Ward (of Auckland), Mr. J. D. McCormick and Wing Commander Todd (Wellington), Messrs. D. H. Webb and J. B. Gordon (Christchurch), Messrs. J. P. Senior and D. Byers (Combined Branch Councillors).

Auckland Branch:
Secretary: Mr. P. L. Watts, c/o P.O. Box 3325, Auckland.
Chairman: Mr. B. D. Ward.

Wellington Branch:
Secretary: Mr. L. J. Whetton, P.O. Box 5106, Wellington.
Chairman: Mr. J. D. McCormick.

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Secretary: Mr. W. P. Anderson, 39 Mortlake Street, Islington, Christchurch, 4.
Chairman: Mr D. H. Webb.

Membership of the Institute is open to all interested in Electronics and its role within New Zealand. Regular meetings are held in all branches.

able for potting and impregnating coils and transformers, and are a substitute for silicone where high temperatures are not required.

The heat rise over ambient of the polyurethanes is very low, so that they are suitable for heat sensitive elements. Scotch-cast resin No. 221 is an unfilled, flexible, transparent, two-part room curing, resin system, recommended for potting and encapsulating. For greater mechanical strength, hardness or increased thermal conductivity, No. 222 resin should be used. This is a filled resin. No. 224 is a filled, semi-flexible, two-part resin, suitable for potting and encapsulating in areas where a tougher coating with higher mechanical strength is critical, such as for motor windings, casting and coil encapsulating.

ENQUIRY 665

NEW STABILITY LEVELS IN DIGITAL COUNTING

It is now possible to obtain optional oscillator stability to suit the user in a new range of Digital Counter Timers.

Aging rates over 24 hours are better than:

Medium Stability 3 parts in 10^9
High Stability 1 part in 10^9
Super High Stability 5 parts in 10^{10}
Basic instruments to 5, 10, 50, 100MHz
Plug-in units to 15GHz
Systron-Donner Digital Instruments
Distributed by Sample Electronics (N.Z.) Limited.

ENQUIRY 628

PIXIE POT

From Duncan Electronics comes the news of the latest addition to the multi-turn potentiometer range dubbed "Pixie-pot" it is 7/8in diameter 3/4" long only weights 1/2 oz. It is a full ten turn unit with gold plated terminals and rotational life expectancy of over 1/2 million turns.

Resistance range from 100 ohms to 100K ohms, linearity better than ±0.25 per cent. Resolution of a 1K pot for instance is 0.022.

Rating is 2 watts. Priced below $8 N.Z. in lots to 25 it will fit standard Duncan or other turns counting dials.

New catalogues in course of preparation and will be forwarded to genuine enquirers on letterhead enquiries.

ENQUIRY 625

NEW DATAPULSE MODEL 101

Compact size and low price make the 101 an excellent tool for the instruction of solid-state circuit design, digital logic, and other basic engineering subjects. It is easy to use and rugged. It can't be damaged, even by students, under normal operating conditions.

With the 101 you can generate stable pulse bursts and gated digital signals. You can count down its output for frequency division. Trigger it from any points on an AC line voltage waveform to control phase of SCR's and thyratrons. With its fast clean pulses you can analyse storage and recovery time effects. With two 101's you can simulate beacon type signals.

Available for demonstration
Sample Electronics (N.Z.) Limited.

ENQUIRY 629

SOLID-STATE 2-MC/S FREQUENCY COUNTER

A new solid-state low-cost 2-Mc/s frequency counter is now available.

The Model 6010 A EPUT Meter measures frequencies, periods and multiple period averages, and random or repetitive pulses representing physical phenomena. In addition, the instrument is capable of measuring frequency ratios and multiple ratio averages.

With a high input sensitivity of 00mV rms and d-c coupling, the 6010A can accommodate a variety of input signal configurations.

The instrument's many applications include checkout of precision oscillators or communications equipment, calibration of signal generators, and monitoring in computer or telemetering systems.

ENQUIRY 624

INTEGRATED CIRCUITRY DEVELOPMENT AND MANUFACTURING WELL UNDERWAY

Six new diode transistor logic (DTL) integrated circuits (ICs) and nine transistor-transistor logic (TTL) ICs were recently placed on the domestic market with a simultaneous surprise announcement that Toshiba has been engaged in IC research and development since 1961.

Last year an assembly line with a monthly output of 200,000 ICs went into operation at the Transistor Works in Kawasaki. It is anticipated that by 1968 monthly IC production will be in excess of one million units.

A specially developed dust-proof chamber at the IC assembly facility is believed to be the world's most efficient. Consequently Toshiba IC production yield rate is also believed to be the highest in Japan.

Another announcement revealed the development of two types of MOS ICs for use in 16-digit memories of electronic computers. A conventional 16-digit computer memory requires 1,000 components, but only 24 Toshiba MOS ICs will be needed.

ENQUIRY 623

ELECTRONIC DESK-TOP CALCULATOR, MOST COMPACT, ECONOMICAL

The most compact, lowest-priced electronic desk-top calculator, the BC-1201, is now ready for marketing. The BC-1201 weighs only 11.6 kilograms (25.5lbs).

All circuitry withing the BC-1201 is completely solid-state and its action is completely electronic. Twelve digit calculation is possible from a standard ten-key numeral operator panel board. A warning indicator lights up in the rare instances when the calculator's digit capacity is exceeded. Pre-set decimal-point positions facilitate decimal calculations.

Noise-free, simple operation and rapid calculations are other features of the BC-1201. Models are available upon order for 100, 110, 115, 120, 125, 200, 220, 230, and 240 volt 50 or 60 cycle power sources.

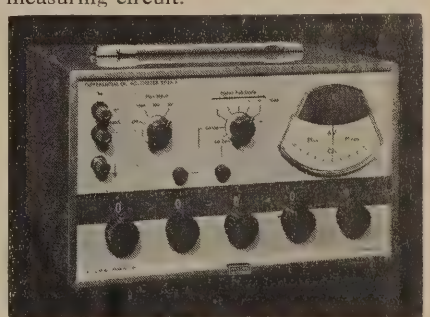
A slightly larger version of the BC-1201, the BC-1411, has been marketed for one year.

ENQUIRY 622

NEW DIFFERENTIAL D.C. VOLTMETER

This D.C. Voltmeter covers the range 0 to 11, 0 to 110 and 0 to 1100 volts, to an accuracy of 0.05% and with a measurement discrimination of 0.0001%; the discrimination is better than 0.1 mV on the 11 volt range.

The TF 2606 is a manually operated voltage measuring instrument with the full accuracy of a high-grade digital voltmeter. It comprises an accurate reference source, a five-decade potentiometer and a sensitive centre-zero electronic voltmeter. Voltages up to 11 volts are measured by comparing the unknown directly with the potentiometer output voltage. Above 11 volts, a high-impedance attenuator is introduced between the input terminal and the measuring circuit.



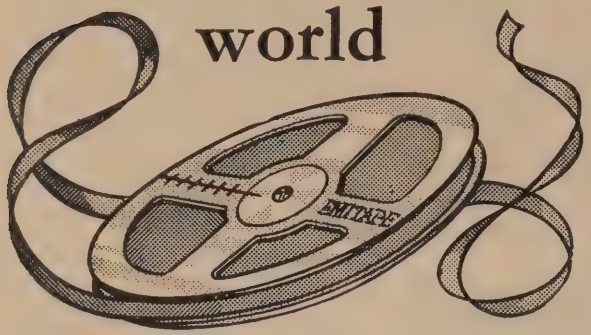
It is very useful, therefore, for measurement of the output e.m.f. of high resistance sources, and for other similar measurements where even the 1 MΩ normally regarded as an acceptable digital voltmeter input resistance can cause errors.

Other important features of the instrument include:

(a) Provision for standardising the reference voltage against a built-in standard cell; (b) the ability of the instrument to indicate small changes in voltage without the necessity to adjust the potentiometer setting manually; (c) the provision of an analogue output suitable for driving a chart recorder directly.

ENQUIRY 621

Emitape magnetic recording tape — the finest in the world



4 GRADES AVAILABLE

"77" Pen-Tested Professional
"88" Standard Play
"99" Long Play
"100" Double Play

Special EMITAPE features include:

* Anti-static
* High sensitivity
* Low 'print-through' factor
* Spool sizes for all tape recorders

MAGNETIC PROPERTIES	PHYSICAL PROPERTIES				
(All grades)	*Width (all grades): 0.246" ± .002"*				
COERCIVITY: 270 Oersteds	TYPE:	77	88	99	100
RETENTIVITY: 0.6 Maxwells	Base Thickness (μ)	37.5	37.5	25.0	15.2
BACKGROUND NOISE: At least 64dB below Peak Recording Level	Coating Thickness (μ)	12.5	12.5	12.5	9.2
MODULATION NOISE: At least 56dB below Peak Recording Level	Tensile Strength (lbs)	9.0	9.0	5.5	6.0
PRINT FACTOR: At least 52dB below Peak Recording Level after storage for 72 hrs. at 65°F	Yield Point (lbs)	4.75	4.75	2.75	4.0
	Elongation at 0.5 lb load (%)	0.25	0.25	0.34	0.34
	Humidity Expansion (per 1% RH) 12 x 10⁻⁵	NEGLIGIBLE			

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ENQUIRY 479. USE FORM AT REAR.

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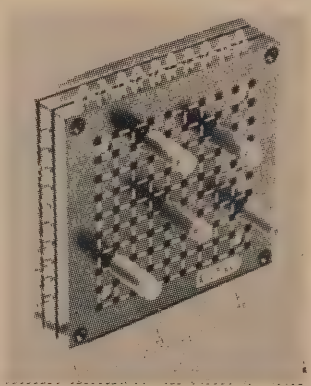
Contractors to the Admiralty and The Ministry of Aviation.
Approved by A.E.R.E., E.I.D., and A.R.B.

Manufacturers of quality printed circuit board accessories including: trimming capacitors, printed circuit sockets, BARB insulators, BARB indicator lamps, neon indicators, quartz trimmer capacitors, sub-miniature plugs and sockets etc.

"CONTROLOX"

ANNOUNCING OXLEY'S MATRIX PROGRAMME BOARD



"CONTROLOX" programming units are suitable for:

- Communication systems
- Automatic process control
- Computers
- Sequential control
- Automatic machine tool control
- Experimental circuit proving
- Teaching machines

The "CONTROLOX" programme system fulfils modern requirements for comprehensive flexible and reliable switching units. The standard matrix blocks (10 x 10 sockets on 0.2" 5 mm module) provides the smallest size compatible with practical ease of operation; (2.48" x 2.48" or 63 x 63 mm.).

Enquiries for non-standard units are welcome.

MOTOROLA SEMICONDUCTORS

NEW PRODUCTS

MOTOROLA MV 1403 Epicaps
(Voltage variable capacitance diodes)

Replace gang tuning capacitors, giving full Broadcast Band coverage (10 to 1 capacity range).

These are the first commercially available units giving full coverage —previously available units were limited to about 8 to 1 allowing for reasonable minimum circuit capacitance.

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ENQUIRY 653. USE FORM AT REAR.

LOW COST UNISEAL DIODES

A new range of fast switching diodes, —the Uniseal range—has been introduced.

These glass encapsulated components employ a very simple form of construction in which the chip is in direct contact with the ends of the two connecting leads, providing a double heat sink and correspondingly improved ratings.

The Uniseal range at present includes several types, a typical specification being:—

p.i.v. 30Vtrr 2.5 ns C 2pf

Connecting leads are tin plated for ease of soldering.

A large production capacity has been established to meet the considerable demand anticipated. This will permit immediate delivery, in quantity, and enables costs to be reduced by as much as 40 per cent.

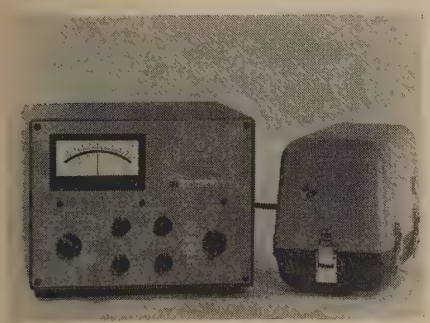
ENQUIRY 620

NANOVOLT GALVANOMETER FROM ANY SOURCE IMPEDANCE

A major design innovation of this new galvanometer-type null detector is its ability to operate from any source resistance without changes in response or damping characteristics.

This is made possible by a unique methods of feedback control. In addition, this extremely sensitive instrument features 120 db ac rejection, infinite common mode rejection, multiple calibrated ranges, and operational simplicity.

ESI's 900 is an ideal null detector for use with many typical laboratory measuring devices, including resistance measuring systems, direct-reading ratio sets, universal ratio sets, and potentiometers.

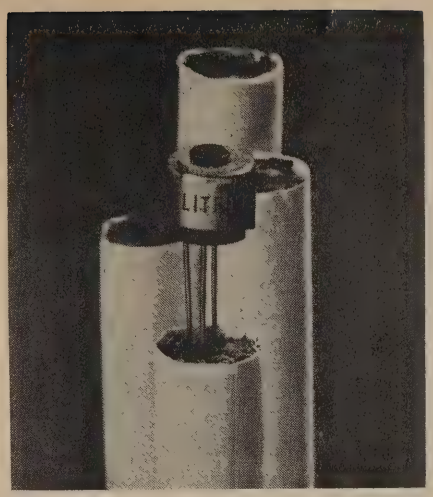


A zero-centred meter with 12 calibrated ranges and controls for range, external emf compensation, zero, and function are located on the control unit. There are no controls on the galvanometer unit, which is connected to the control unit by a single cable and can be located wherever is convenient.

ENQUIRY 618

NEW INDUSTRIAL TRIMMER

Model 62PF is a new 1/4 inch diameter cermet trimmer with printed circuit board pins 5/8 inch long. The single-turn unit offers infinite resolution and standard resistance values from 10 ohms to one megohm. Power rating is ½ watt at 70°C, derating to 0 at 125°C.



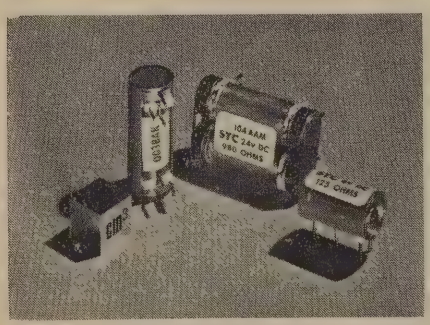
Together with Model 62P (1/4 inch diameter) and the Model 62PA side-adjust version these make important additions to meet virtually every industrial application where miniature components are required.

ENQUIRY 616

SUB-MINIATURE RELAY HAS METALLIC DIAPHRAGM

A robust, high-performance midget relay developed by a British company uses a flexible metallic diaphragm as the moving contact in a simple "make" relay action.

It is less than 1.5 c.c. volume in its basic form and less than 10.5 mm high when mounted on a printed circuit board. Switching capability is 30W, the maximum current being 0.5A and the minimum voltage either 150V d.c. or 250V a.c.



Like a flat-headed rivet in appearance, the switching element is a circular steel enclosure in which the diaphragm is held close to a central fixed contact formed by the end of a cylindrical rod that protrudes to act as a core for the relay coil. When the coil is energised, the diaphragm is attracted to the fixed contact and makes contact over an area of at least 5 sq. mm. At normal excitation, contact force is about 25gm; restoring force is about 10gm. Operating time is about 1.5 milliseconds, including contact bounce; release time is in the order of 500 microsecnds. Mating surfaces are coated with gold, typical contact resistance being 30 milliohms.

Operating life when switching 60V d.c. at 0.5A resistive is at least one million operations. This figure rises to 5,000,000 operations at 60V 100mA, and to 1,000 million operations in dry-circuit conditions.

ENQUIRY 615

INTRODUCTION OF MONOLITHIC CHIP CAPACITORS

These 'Flip-Chip' Capacitors are a major technical advance and offer a wider range of capacitance values to designers of hybrid micro-miniature circuits.

The initial range of chip capacitors covers values from 3.300 pf to 47,000 pf. Extensions in both directions will be available later in 1967. The standard tolerance is ±20 per cent, but ±10 per cent tolerances can be supplied by selection. The effective working temperature is from —60°C to +150°C. The maximum working voltage is 50 V DC.

The size of the new range is only 3.3 mm square, which permits a much greater capacitance for a given area than is available by conventional thin film or integrated circuit techniques. These monolithic chip capacitors, which consist of up to 25 layers of dielectric each as thin as 0.001", are made by casting dielectric powder in the form of a flexible film by dispersing it in organic binders and solvents.

ENQUIRY 619

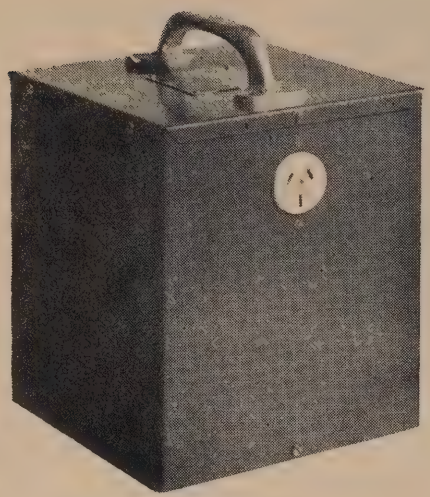
BRITISH TEAM DEVELOP REVOLUTIONARY CONTROL DEVICE

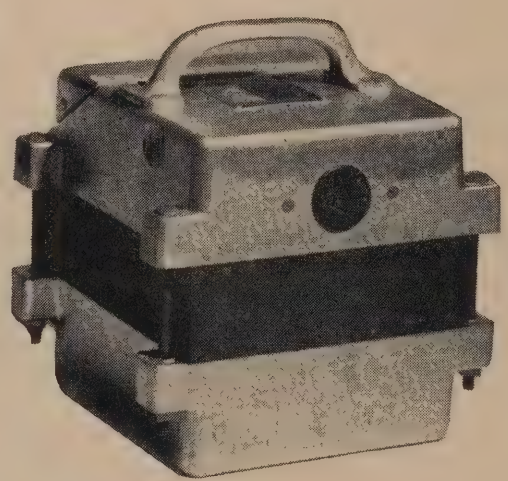
Revolutionary power microcircuits that can bring electronic control of kitchen equipment—and reduce costs into the bargain—have been developed recently by a British company in Lincoln, eastern England.

These prototype control modules have been designed to replace electro-mechanical units controlling small electric motors in domestic equipment—and to replace conventional relays. They can be used on almost anything using a fractional horse-power motor—the first applications probably being washing machines and hand drills, quickly followed by spin dryers, food mixers, electric blankets, ovens and dishwashers.

With automatic production methods, the company estimate that the small devices could sell for about 30 per cent less than current electro-mechanical units as well as offer more sophisticated control and provide easier maintenance.

ENQUIRY 617





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ATC

ENQUIRY 349. USE FORM AT REAR.

COMPACT ULTRA VIOLET RECORDER

The ultra violet recorder—designated type M 1330—is a 10 data recording channel, each with individual input sockets, two datum traces and, as an optional extra, an event marker which enables recorded parameters to be tied to the occurrence of a particular event.

Together with full width timing lines at intervals of 0.01, 0.1, 1 and 10 seconds and optical grid lines every 2 mm., the parameters are recorded on ultra violet recording paper of up to 6 in wide. Paper capacity, using ultra-lightweight paper, is 350 ft.

The gearbox has been designed to give a highly versatile and reliable paper drive mechanism. The standard version allows for a paper speed range from 2,500 mm/sec. to 4 mm/sec. in 12 steps.

Other features of the recorder include remote control, trace identification and paper take-up. The remote control system, fitted as standard equipment, covers record ON/OFF, event marker and external trigger for the timer system. The trace identification feature is an optional extra and provides sequential interruption of all channels from 1 to 10 to facilitate identification anywhere on the record. Paper take-up is also an optional extra.

ENQUIRY 644

SOLID STATE MAGNETIC TAPE REPRODUCER

A new broadcast quality studio console, designed to meet the requirements of the Australian Broadcasting Commission and New Zealand Broadcasting Corporation Specifications.

Designated Model 707, the unit is the first of a new generation of solid state magnetic tape recorders and reproducers to be produced.

The console's electronics, which include replay, line and monitoring amplifiers, are completely transistorised. Telecommunication - grade components include epoxy glass printed circuit boards with edge connectors, silicon transistors and diodes, metal film resistors, tantalum and polyester capacitors and encapsulated transformers and chokes.

The horizontal tape deck is of advanced design. Facilities include an accurate tape footage indicator, single switch change for motor speed and amplifier equalisation, smooth stable speed in less than 0.5 seconds, continuously variable spooling, precision capstan drive motor and complete electromagnetic press button operation. Full remote control facilities are provided.

The equipment is particularly suitable for tape editing purposes, operators having free access to the tape passing over the play head so that accurate editing may be achieved.

ENQUIRY 646

MARVEL OF MICRO MIGHT

Australia has designed and manufactured its first integrated circuit. A complete electronic device fabricated on a chip of silicon, it is so tiny that: 300 of them can be placed on a four cent postage stamp; one can be passed through the eye of a needle; it would take eight million of them to equal the weight of valve equipment doing much the same job.

The minute chip has an area of one four hundredth of a square inch. It contains a broad-band two stage voltage amplifier. Into the silicon square there is diffused a circuit containing four transistors and nine resistors.

The circuits have the advantage of smallness in size and greater reliability. Combined with their technical superiority, these advantages should result in a lowering of manufacturing costs when the Australian-made devices are in use. Already, they are used extensively in computers and in data transmission as well as in military electronics and space research.

The firm look forward to their local application in the many and varied electronics fields, particularly in all types of communications equipment and in consumer products. Ultimately, they would form a substantial part of electronic equipment generally.

An instance quoted of how these very small devices can perform functions which previously involved the large scale use of components is that of two digital computers. One had about 8,500 separate conventional components; the other, 587 integrated circuits. The former unit was 150 times larger and 48 times as heavy as the one using integrated circuits.

ENQUIRY 647

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SEPTEMBER, 1967

SAMPLING OSCILLOSCOPE

A new high performance sampling oscilloscope, type 3410, claimed to be as simple to use as a conventional real time instrument is a dual trace instrument with a sensitivity of 1 mV/cm and a rise time of 0.35 ns (1,000 Mc/s bandwidth).

A 35 ns delay line is incorporated in each channel. The cathode ray tube has a 10 × 8 cm rectangular screen, all of which is available for display. A single trigger control covers the whole range up to 1,000 Mc/s. A symmetric (as opposed to the customary asymmetric) sweep expansion control allows the trace to be expanded up to 100 times about the centre of the screen. Time base sweep speeds are from 1 ns/cm to 10 μs/cm, and the sampling rate is 10, 100 or 1,000 samples/cm. Provision is also made for scanning to be effected manually or by an external voltage. An internally generated slow ramp adjustable from 1 to 60 s per sweep allows a permanent trace to be made by an ordinary pen recorder.

ENQUIRY 650

CHEAPER THYRISTOR CONTROLLER

Inexpensive, three-phase adjustable speed drives for controlling motors between 7½ and 350 hp have been developed Quinton-Crane Electronics.

The controller can be fitted to most capital equipment, at reduced cost, for example: 10 hp three-phase thyristor motor controller will now cost $900, as against a typical cost of $1,500; and a 100 hp motor controller $5,400, as against $6,400. The d.c. supply to the motor armature is derived from a three-phase full-wave bridge rectifier, with three thyristor arms. The motor shunt field is supplied by an integral rectifier unit to give constant torque characteristics over the speed range. This integral rectifier unit can be replaced by a thyristor field controller to give constant horsepower characteristics over 3 : 1 speed range.

Field failure protection networks are included. The drives are protected against transients by surge suppressors. The bridge controller is fitted with high-speed semiconductor fuses and is designed for use with light compounded shunt wound, separately excited d.c. motors.

ENQUIRY 648

HIGH-RESOLUTION CATHODE RAY TUBE

A high-resolution cathode ray tube, featuring a 4-inch-long raised cylindrical fibre optic faceplate and a yoke-shield assembly for aerial photography, single-line scan display, side-looking radar and film recording, is announced.

The raised fibre optic faceplate is curved to permit direct film contact without the need for a pressure roller. It also eliminates the need for a bulky, complicated and expensive lens system.

Because the tube and the yoke-shield is a mated precision assembly, the supplier is able to guarantee a maximum centre spot size of 0.0007 inch and an edge spot size of 0.0008 inch. This resolution is attained with an anode voltage as low as 10 kilovolts. Full spot size capabilities of the tube can be realized from centre to edge. **ENQUIRY 645**

MINIATURE COAXIAL CONNECTOR

Manufactured in France and available through Lectropon is a range of miniature screw-type coaxial connectors to MIL.C.22557A. The Subvis range is fully interchangeable with DEF.5322A Pattern 107 series. Characteristic impedance 50 Ω; frequency range 0 to 10,000 Mc/s; temperature range —65°C to +125°C; test voltage (mated pair) 1,500 V at sea level, 525 V at 45,000ft and 375 V at 65,000ft. Insulation resistance greater than 1,000 MΩ at 500 V d.c.; contact resistance less than 5 mΩ at 1 A d.c. **ENQUIRY 649**

SERIES 130 (A.C.) RELAY SERIES 135 (D.C.) RELAY)

Miniature relays similar to Series 120/125 Relays but with three pole changeover contacts as standard.

The Series 130/135 Relays are enclosed in a transparent Makrolon cover, which does not support combustion. The relay is mounted on an 11 pin moulded base with adequate anti-tracking barriers. Conforming generally to the Ministry of Aviation Specification DEF. 5000, the Coil can be vacuum impregnated for humid or tropical conditions.

Coil Rating: Series 130, Nominal Power, 3.5 VA; Maximum working voltage: 250 volts; Maximum coil resistance: 7300 ohms. Series 135: Nominal power, 1.5 watts; Maximum working voltage: 125 volts; Maximum coil resistance: 7300 ohms.

Maximum weight: 3 ozs.

ENQUIRY 643

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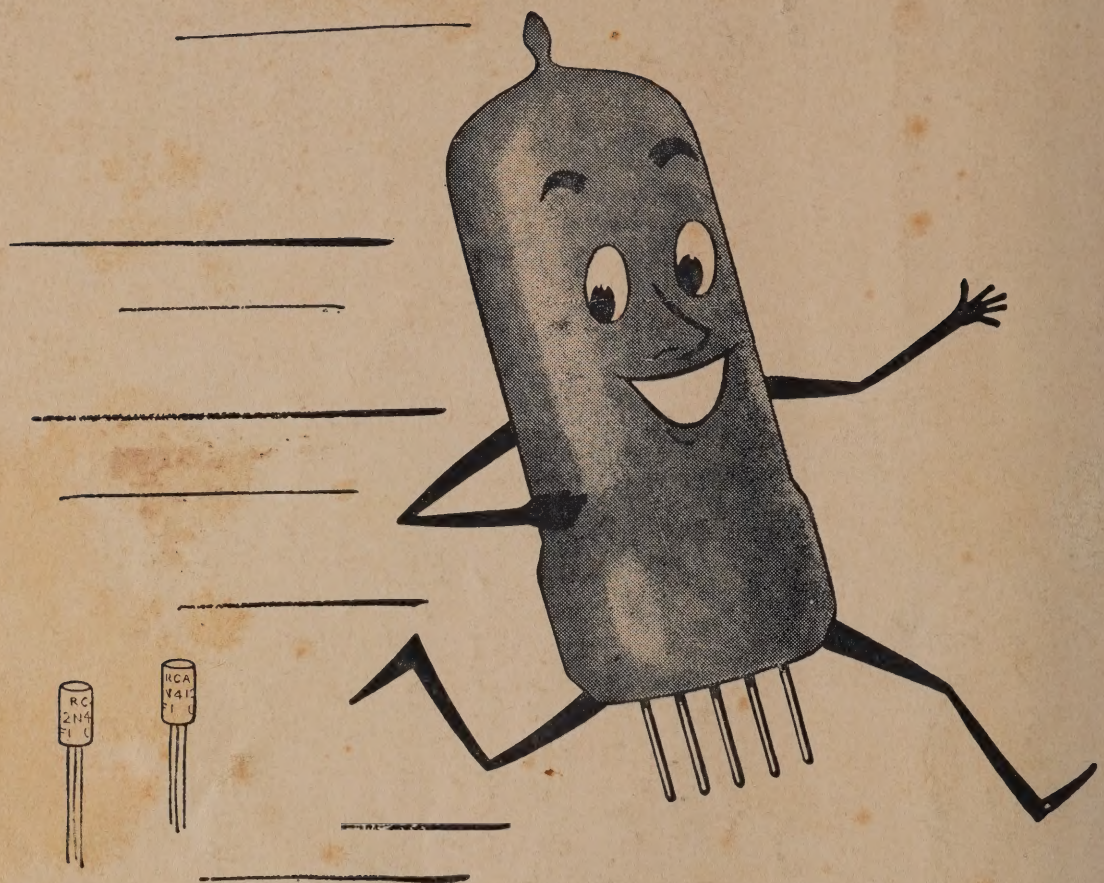

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ENQUIRY 410. USE FORM AT REAR.